

2164

---

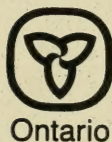
---

**STOPPING  
WATER POLLUTION  
AT ITS SOURCE**



**PERFORMANCE AND COST EVALUATION  
OF BEST AVAILABLE TECHNOLOGY OPTIONS  
FOR THE ONTARIO INORGANIC  
CHEMICAL SECTOR**

---



**Environment  
Environnement**

21/10/92

---

---



ISBN 0-7778-0209-0

PERFORMANCE AND COST EVALUATION  
OF BEST AVAILABLE TECHNOLOGY  
OPTIONS FOR THE ONTARIO  
INORGANIC CHEMICAL SECTOR

OCTOBER 1992



Cette publication technique  
n'est disponible qu'en anglais.

Copyright: Queen's Printer for Ontario, 1992  
This publication may be reproduced for non-commercial purposes  
with appropriate attribution.

PIBS 2164  
Log 92-2310-049







PERFORMANCE AND COST EVALUATION  
OF BEST AVAILABLE TECHNOLOGY  
OPTIONS FOR THE ONTARIO  
INORGANIC CHEMICAL SECTOR

Report prepared for:

MISA Office  
Ontario Ministry of the Environment

Report prepared by:

CH2M HILL ENGINEERING LTD.  
2000 Argentia Road, Suite 100, Plaza 3  
Mississauga, Ontario L5N 1V9

OCTOBER 1992

PIBS 2164



## **MINISTRY NOTE**

This report was produced as a reference document for the effluent limits development process for the Ontario Inorganic Chemical Sector (ICS).

The information presented will be used as a basis for setting effluent limits based on Best Available Technology for each of the Ontario ICS plants.

The report however may not be the sole basis on which limits for the ICS will be developed. Other sources of information, which are acceptable to the ICS Joint Technical Committee, may also be used in the limit setting process.

The views and ideas expressed in the report are those of the author and do not necessarily reflect the views and policies of the Ministry of the Environment, nor does mention of trade names or commercial products constitute endorsement or recommendation of their use.





## **TABLE OF CONTENTS**

### **VOLUME 1 - STUDY REPORT**

<b>SECTION</b>	<b>PAGE</b>
1. INTRODUCTION	1-1
2. STUDY METHODS	2-1
2.1 Site Visits and Reporting	2-1
2.2 Review of Background Material	2-1
2.3 Site Visits	2-2
2.4 Site Visit Reports	2-3
2.5 Selection of BAT Options for the Ontario Inorganic Chemical Sector	2-3
2.5.1 BAT Option 1	2-5
2.5.2 BAT Option 2	2-5
2.5.3 BAT Option 3	2-6
2.5.4 BAT Option 4	2-6
2.5.5 BAT Option 5	2-7
2.6 Estimating Costs and Performance of BAT Options	2-7
2.6.1 Cost Estimates	2-7
2.6.2 Projected Performance	2-8
3. SITE VISIT REPORTS	3-1
4. BAT OPTION REPORTS	4-1

### **VOLUME 2 - BAT OPTION REPORTS**

APPENDICES (1-27)

### **VOLUME 3 - ONTARIO SITE VISIT REPORTS (UNPUBLISHED)**

APPENDICES (1-27)





## **LIST OF TABLES**

<b><u>Table</u></b>		<b><u>Page</u></b>
2.1	Ontario ICS Plant Site Visit Dates	2-9
2.2	Outline of Site Visit Reports	2-10
2.3	Outline of BAT Option Reports	2-11
3.1	Overview of ICS Plants	3-2
4.1	Summary of BAT Options Recommended for Ontario ICS Plants	4-2



## **VOLUME 1 - STUDY REPORT**





## Section 1 INTRODUCTION

### **BACKGROUND**

The Ontario Ministry of the Environment's (MOE) Municipal-Industrial Strategy for Abatement (MISA) program was initiated in 1986 to strengthen the controls on water pollution in the Province. The ultimate goal of the MISA program is the virtual elimination of persistent toxic contaminants from all discharges to Ontario's waterways.

The first phase of the MISA program involved the development of effluent monitoring regulations for nine direct discharging industrial sectors. These regulations require many direct dischargers to monitor flows and contaminants in their point source discharges. The second phase will involve the development of effluent limits regulations for each of the nine industrial sectors.

In order to develop effluent limits, pollution control technologies available to the industry for removal of contaminants must be evaluated. Furthermore, the financial and economic impacts of these technologies on the industry must be known. The best available technology (BAT) economically achievable (EA) for the industry can then be determined, and will form the basis for setting effluent limits.

To this end, the MOE called for a two phase study to develop an inventory of BAT applicable to plants in the Ontario Inorganic Chemical Sector (ICS), as follows:

- **Global Study** - Development of an inventory of BAT applicable to the Ontario ICS plants, through a search carried out in Canada, U.S., Europe and elsewhere.
- **Ontario Study** - Evaluation of predicted performance and estimated costs of the recommended BAT options if installed at each Ontario ICS plant.

This report presents the results of the Ontario Study.

### **ONTARIO INORGANIC CHEMICAL SECTOR OVERVIEW**

There are 27 plants in the Ontario ICS, ranging from small single product operations to large multi-product facilities. With few exceptions, each plant is unique in terms of size, products manufactured and wastewater generation and management. The following broad categories represent the range of plants included in the group:

- Industrial gas (6 plants)
- Abrasives (4 plants)

- Nitrogen fertilizers and nitrogen products (4 plants)
- Carbon black (2 plants)
- Phosphate products (2 plant)
- Soda ash (1 plant)
- Hydrofluoric acid and chlorofluorocarbons (1 plant)
- Aluminum chloride (1 plant)
- Chlor-alkali (1 plant)
- Mineral wool insulation (1 plant)
- Carbon and graphite electrodes (1 plant)
- Industrial liquid and gas packaging (2 plants)
- Explosives (1 plant).

Wastewater generated within the industry, by virtue of the products manufactured, contains a number of conventional and priority pollutants. Conventional pollutants found include suspended solids, acids, bases, chlorides, phosphorus, fluoride and nitrogen compounds. Priority pollutants include heavy metals as well as organic contaminants. Industry effluent flows range from less than 25 m<sup>3</sup>/d to greater than 250,000 m<sup>3</sup>/d.

Physical chemical treatment processes as well as in-plant wastewater management measures are currently used in the Sector to reduce contaminant loadings to receiving waters. Currently, some plants do not provide treatment, while others provide varying levels of treatment. Since effluent quality varies widely between plants, so does the range of applicable treatment.

The majority of the ICS plants are located in two general regions of Ontario: the Niagara Peninsula and south western Ontario (Sarnia area). However, there are a few plants outside of these areas, in Sault Ste. Marie, North Bay, Cornwall and Elmira.

## **STUDY DESCRIPTION AND OBJECTIVES**

The primary purposes of the Ontario study was to identify BAT Options for each of the Inorganic Chemical Sector plants based on information provided in the Global Study and to predict the performance and estimate the costs of each BAT Options, if they were implemented at each Ontario Inorganic Chemical Sector Plant.

The specific objectives of the study were:

1. To review the current status of the ICS plants with respect to effluent treatment, best management practices, in-plant controls and stormwater management.
2. To recommend, where possible, up to five options for BAT for each Ontario ICS plant based on information gathered in the Global study and selected according to the following criteria:



- A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
  - The BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
  - A BAT option that uses the best technology currently in use in Ontario.
  - A BAT option that is predicted to provide the maximum overall pollution reduction.
  - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.
3. To calculate the probable performance, including variability, of each of the recommended BAT Options if installed in the ICS plants.
  4. To provide order-of-magnitude costs for BAT Options judged likely to provide improved performance if installed at each of the ICS plants.
  5. Where possible, to simplify the above by grouping plants to which similar technologies will apply.

## **CONTENTS OF REPORT**

Section 2 of the report presents the methodologies used in the Ontario study and documents information sources. Information requested at the plant site visit is described. The rationale used in developing BAT Options for each plant is described as well as methods for assessing the performance and cost of each BAT Option at each site.

Section 3 presents an overview of Inorganic Chemical Sector plants, which includes products, manufactured and wastewater management. In Section 4, summary tables presenting BAT Options and associated costs and performance are presented for each plant.



## **Section 2**

### **STUDY METHODS**

#### **2.1        SITE VISITS AND REPORTING**

In order to review and document the current status of the ICS plants with respect to effluent treatment, best management practices, in-plant controls and storm water management, several tasks were undertaken. These included:

- Review of background materials.
- Site visits.
- Preparation of site visit reports.

Each activity is discussed in the following sub-sections.

#### **2.2        REVIEW OF BACKGROUND MATERIAL**

The purposes for the review of background materials for each of the 27 plants in the sector were as follows:

- To enable study engineers to become familiar with the plants prior to the site visit.
- To develop a list of additional information to be obtained during the site visit.
- To establish the current status of wastewater management and treatment at each of the plants.

Information available for review on each plant was contained in files held by the Ontario Ministry of the Environment MISA Office. These were examined by CH2M HILL engineers who were to conduct the site visit at each specific plant. Initial Reports filed by each plant during the development of the MISA monitoring regulations provided background information on:

- Plant site layout
- Production processes and process flow diagrams
- Raw materials and products
- General usage materials
- Water conditioning chemicals
- Wastewater sources
- Effluent treatment systems
- MISA sampling locations.

The completeness of these reports varied considerably from plant to plant.

From the initial information review, a list of information requirements was developed and sent in a letter to each plant representative. These letters also confirmed the date and time of the site visit.

### 2.3 SITE VISIT

The specific objectives of the site visits were to:

- Confirm that the information received in the Ministry's information packages was current and complete, and to update or include any or missing information.
- To identify potential factors that would need to be considered in the implementation of the recommended BAT options at the plant. These could include land area requirements, piping layouts, modifications for retrofitting, process shut downs during implementation, geotechnical conditions, labour and energy requirements, and opportunities and costs of disposing of wastewater treatment residuals.

Site visits were conducted on the dates presented in Table 2.1 for each plant in the Ontario ICS. A representative of the Ministry of Environment participated in each site visit, with the exception of the site visit at Linde (Sault Ste. Marie). In some instances, information requests made at the time of the site visit required follow-up over the phone to complete data gathering.

Generally, site visits took less than one day, although at some of the more complex plants, visits extended to two days. All visits except one were carried out in the period of March and April 1991.

Onsite activities that were carried out by the project engineer with the co-operation of the plant contact person included:

- A tour of the plant.
- Examination of floor plans, piping layouts, etc. of the plant, if available.
- Examination of in-plant records, including in-house operation and performance monitoring, waste disposal records, etc.
- Review of drawings and design summaries for wastewater treatment processes and wastewater control technologies.

- Review of other waste or wastewater control documentation, e.g. best management practice plans, operators manual, training records, etc.
- Interviews with plant contacts and appropriate plant personnel.

## 2.4 SITE VISIT REPORT

The information gathered from the Ministry files and the site visits was compiled into an individual site visit report for each plant. The report was organized to present information relevant to the selection and costing of BAT Options.

A standardized site visit report format was used which is shown in Table 2.2. This provided a consistent presentation of plant information, and ensured a comprehensive report was prepared to cover all of the following areas:

- General plant description.
- Manufacturing process description.
- Water use and treatment.
- Wastewater and storm water sources.
- Pollution prevention.
- In-plant and end-of-pipe treatment.
- Effluent monitoring.
- Best management practices.

Each draft site visit report was submitted to the respective plant for review of accuracy of information. Comments provided by industry were incorporated into final reports.

## 2.5 SELECTION OF BAT OPTIONS FOR THE ONTARIO INORGANIC CHEMICAL SECTOR

In accordance with the study requirements, five BAT Options were identified for the management of wastewater, excluding storm water runoff, discharged from plants in the sector. These options were:

- Option 1:** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2:** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3:** - A BAT option that uses the best technology currently in use in Ontario.



- Option 4:** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5:** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

In the Global study, information on technologies used in the inorganic chemical manufacturing industry world-wide was compiled. This information was used to identify wastewater management technologies applicable to each of the 27 Ontario plants for each of the five BAT Options. In addition, the Global study provided information on technologies applicable to reducing the levels of specific wastewater pollutants in industrial wastewaters. These technologies were included in the Global Study because of their demonstrated effectiveness in reducing contaminant discharges at other industries, with similar wastewater quality to plants in the Ontario Sector.

The discussion below present the rationale for selection of technologies applicable to each Inorganic Chemical Sector Plant, from the inventory of technology information provided in the Global Study.

It is important to note that the treatment technologies included in the recommended BAT options are not necessarily the required technologies to be installed since the same level of treatment may also be achieved by the use of in-plant controls, pollution prevention measures or other technologies. The technologies quoted are used as a "model" for estimating treatment performance and costs and are not necessarily intended to be a list of suitable technologies for meeting specified effluent limits.

In many cases, technology selection was based not only on the manufacturing processes and existing wastewater management at the Ontario plant, but also on the quality of wastewater effluents. This quality was defined in terms of "Priority 1" pollutants, established by the Ministry from data collected during the 12-month MISA Monitoring Regulation period at effluent monitoring stations at each plant. Furthermore, toxicity testing results from the first six months of MISA monitoring were utilized to define the toxicity of effluents at each plant.

Summaries of the twelve month monitoring database used in assessing performance improvements for the BAT options are shown in the Appendixes of each BAT Option report contained in Volume 2. Also included are a final set of tables showing the finalized twelve month monitoring database. There may be minor discrepancies between the two sets of tables, however, these discrepancies do not have an impact on the report recommendations.

## 2.5.1 BAT Option 1

The criterion on which the selection of technologies for BAT Option 1 was based on the achievement of non-lethality of effluents. Lethality was defined by results of acute lethality tests on rainbow trout and Daphnia magna, carried out on full strength wastewater samples according to published protocols. Other toxic and sub-lethal effects were not considered in the definition of non-lethality.

Assessments of toxicity results in this report were generally based on the first six months of the monitoring period. Toxicity results for the second six months will be assessed independently by the Ministry. Depending on these second set of results however, some sites may be re-designated as having a lethal effect, despite non-lethal designations in this report.

Where the majority of acute toxicity test samples from the first six-months of MISA monitoring achieved non-lethal results, technologies beyond the existing wastewater management system were not recommended.

Several plants generated wastewaters over the MISA Monitoring period that produced lethality to test organisms. Information on the cause of the toxicity was not available. Therefore, MISA monitoring data was reviewed to identify target contaminants potentially contributing to toxicity. A minimum level of technology implementation was then recommended under BAT Option 1 to produce non-lethal levels of the target contaminants. This method did not allow identification of the synergistic toxic effects of low levels of several contaminants, nor did it include technologies to mitigate these effects.

Furthermore, for effluents from a few Ontario plants, the cause of effluent lethality could not be readily evaluated from the available monitoring data. In these cases, no technology recommendation was provided and BAT Option 1 included the recommendation to conduct a Toxicity Identification and Reduction Study.

It is important to note that despite some overall generalizations that may have been made in assessing toxicity data, the Ministry's position is that a Toxicity Investigation Evaluation will be recommended for effluent streams where at least one toxicity test failure has been recorded based on the full twelve month database.

## 2.5.2 BAT Option 2

In the 1970s, the U.S. Environmental Protection Agency (EPA) conducted a detailed review of technologies used for wastewater management in several categories of the U.S. inorganic chemical manufacturing industry. From this information, best practicable technologies (BPT) and best available technologies (BAT) were recommended for each manufacturing category. BPT addressed the control of conventional contaminant discharges, where as BAT incorporated a higher level of technology aimed

at controlling persistent toxic contaminants. U.S. Federal Regulations, promulgated in 1980s and limiting discharges of target contaminants from certain categories, were developed based on reported achievable concentrations with BAT. Several parts of the U.S. Federal Register, July 1, 1989 Edition, contain these effluent limits.

In order to identify BAT Option 2 technologies for Ontario Inorganic Chemical Sector plants, wastewater control methods, in terms of both technologies and achievable effluent quality were compared to those defined by the U.S. EPA. If effluent quality at the Ontario plant met U.S. effluent limits defined in the regulation, then more advanced technologies were not recommended. Where the Ontario plant did not achieve U.S. limits, technologies were recommended so that the Ontario plant would achieve these limits. Technologies included in BAT Option 2 were not necessarily those defined as U.S. BAT. In some cases, less expensive alternatives appropriate to the specific plant, which would achieve U.S. effluent limit levels or better, were recommended.

For several manufacturing categories included in the Ontario Inorganic Chemical Sector, U.S. BAT was not defined. In this case, recommendations were not made for BAT Option 2.

### **2.5.3      BAT Option 3**

BAT Option 3 for each plant included technologies that represent the best demonstrated wastewater control for comparable facilities in Ontario. Because of the diversity of manufacturing operations within the Inorganic Chemical Sector, 14 of the 27 plants were considered the best, by virtue of the fact that they were the only plant of their kind in the Province.

For the remaining plants, groups producing the same products were examined with respect to wastewater management. Where applicable, the best demonstrated technologies represented in a group were applied to other plants in the group.

### **2.5.4      BAT Option 4**

BAT Option 4 recommended for each plant included a combination of demonstrated, applicable industrial wastewater management technologies identified in the Global Study, that would provide maximum reduction of all "Priority 1" parameters.

A pollution prevention approach, through process materials substitution or elimination, process change and management practices for pollution control was given first priority in the development of recommendations. Where practical pollution prevention measures were unavailable, recommendations included in-plant and end-of-pipe treatment technologies.



## **2.5.5**

### **BAT Option 5**

BAT Option 5 recommendations were developed to bring the plant furthest toward zero discharge of contaminants. Since BAT Option 4 maximizes contaminant removal, BAT Option 5 includes reduction, reuse and recycling of process wastewater to move further toward zero discharge.

## **2.6**

### **ESTIMATING COSTS AND PERFORMANCE OF BAT OPTIONS**

The primary objective of the Ontario study was to estimate capital and operating costs, and project performance that would result if each of the five BAT Options were implemented at the 27 Ontario Inorganic Chemical Sector plants.

The following sub-sections present the general methodologies used to calculate costs and performance estimates. Table 2.3 presents an outline of the individual plant reports prepared to present the BAT Options, and their associated cost and performance impacts.

### **2.6.1**

#### **Cost Estimates**

Cost estimates were developed for the application of recommended BAT Options using information primarily from the Global Study, which summarized capital and operating costs from the following sources:

- Specific projects carried out by plants in U.S. and Canada, visited or contacted as part of the Global Study.
- Information provided by certain Ontario Inorganic Chemical Sector plants on technologies being considered for implementation.
- Budget cost estimates provided by the suppliers of wastewater treatment technologies and chemicals, and waste haulers.
- Cost information from the literature, including cost curves.
- In-house information from the inventory of wastewater treatment projects designed and implemented by CH2M HILL in Canada and the U.S.

Capital costs developed for the Global study included allowances for installation, engineering, contingency and the Good and Services Tax (G.S.T.). All costs were indexed to the Engineering News Record Construction Cost Index of 6343.



Several factors were considered when costs presented in the Global Study were translated for calculating the costs of implementing the technology at the Ontario plant. These factors generally focused on any outstanding features at the plant that would affect the cost of implementation such as:

- Land area availability.
- Existing equipment that could be used in the application.
- Additional piping and pumping station requirements.
- Other site specific features.

Capital and operating costs provided in the Global study were not necessarily for technologies of similar size to the Ontario plant for which it was recommended. In some cases, scaling factors were available. Where unavailable, in-house information on appropriate factors to scale costs were used.

Despite site specific requirements, detailed design and cost estimates, and operating requirements could not be established within the scope of the study. Therefore, cost estimates for BAT Options should be considered order-of-magnitude.

#### **2.6.2      Projected Performance**

The projected performance that would result with the implementation of BAT Options was calculated for each plant based on information from the following sources:

- Reported performances achievable for technologies summarized in the Global study.
- Performance estimates based on fundamental principals.

A number of assumptions were made to estimate probable performance that would be achieved with the implementation of BAT Options. These assumptions are documented in the BAT Option reports for each plant.

**Table 2.1**  
**Ontario ICS Plants Site Visit Dates**

<b>Plant</b>	<b>Date</b>
Albright and Wilson Americas	March 18, 1991
Allied Chemicals Canada	April 15, 1991
Cabot Canada Limited	March 19, 1991
Columbian Chemicals Canada Limited	March 18, 1991
Conpak	April 25, 1991
Cyanamid Canada Inc., Niagara Plant	March 26, 1991
Cyanamid Canada Inc., Welland Plant	March 27, 1991
Exolon ESK Company of Canada Limited	March 22, 1991
Explosives Technologies International	April 2, 1991
General Chemical Canada Limited	April 18, 1991
ICI Canada Inc., Cornwall Works	April 23, 1991
ICI Canada Inc., Nitrogen Products, Lambton Works	April 11, 1991
International Minerals and Chemical Corporation (Canada) Limited	March 21, 1991
Linde (Division of Union Carbide Canada Limited, Moore Township Plant)	March 20, 1991
Linde (Division of Union Carbide Canada Limited, Sarnia Plant)	March 21, 1991
Linde (Division of Union Carbide Canada Limited, Sault Ste. Marie Plant)	April 1, 1991
Liquid Carbonic Inc., Courtright	March 29, 1991
Liquid Carbonic Inc., Maitland	April 25, 1991
Nitrochem Inc.	May 2 and 3, 1991
Norton Advanced Ceramics of Canada Inc.	March 21, 1991
Partek Insulations Limited	March 19, 1991
Puritan-Bennett Corporation	April 25, 1991
Sulco Chemicals Limited	March 19, 1991
UCAR Carbon Canada Inc.	March 27, 1991
Washington Mills Electro Minerals Corporation	March 25, 1991
Washington Mills Limited	March 25, 1991
Welland Chemical Limited	March 18, 1991

**Table 2.2**  
**Outline of Site Visit Reports**

<b>1.0 PLANT SITE</b>
<ul style="list-style-type: none"> <li>Contact name, plant address, telephone and facsimile numbers and date of site visit are provided.</li> </ul>
<b>2.0 PLANT DESCRIPTION</b>
<ul style="list-style-type: none"> <li>Plant size in terms of number of employees, amount of production or other data.</li> <li>Brief description of water and wastewater management at the site, including listing of MISA Control Points.</li> </ul>
<b>3.0 PRODUCT/PROCESS DESCRIPTION</b>
<ul style="list-style-type: none"> <li>Detailed description of products and production processes, especially for those processes producing wastewater.</li> </ul>
<b>4.0 LIST OF CHEMICALS</b>
<ul style="list-style-type: none"> <li>Changes to list submitted with MISA Initial Report noted.</li> </ul>
<b>5.0 WATER MANAGEMENT</b>
<b>5.1 Water Supply</b> <ul style="list-style-type: none"> <li>Source and flow rate of water to plant is described.</li> <li>Chlorination or other intake water treatment is noted.</li> </ul>
<b>5.2 Sources of Wastewater</b> <ul style="list-style-type: none"> <li>Sources of all types of wastewater are described, along with corresponding MISA Control Point number.</li> </ul>
<b>5.3 Sewer Segregation</b> <ul style="list-style-type: none"> <li>The extent of segregation of process, cooling and storm water flows is described.</li> </ul>
<b>5.4 Cooling Methods</b> <ul style="list-style-type: none"> <li>Cooling water uses are identified as contact or non-contact and as once through or recirculated through the use of cooling towers.</li> </ul>
<b>5.5 Pollution Prevention</b> <ul style="list-style-type: none"> <li>Examples of pollution prevention already in use at the plant are described, such as: <ul style="list-style-type: none"> <li>changes in production processes,</li> <li>chemical substitution,</li> <li>in-plant controls,</li> <li>best management practices,</li> <li>water conservation through reduction, reuse or recycle.</li> </ul> </li> </ul>
<b>6.0 WASTEWATER TREATMENT</b>
<ul style="list-style-type: none"> <li>Wastewater treatment at the site is described.</li> <li>Influent/effluent performance data and capital and operating costs for treatment units are documented when the company provided such information.</li> </ul>
<b>7.0 MONITORING DATA</b>
<b>7.1 Current Monitoring</b> <ul style="list-style-type: none"> <li>The contaminants and frequency of current monitoring are documented.</li> </ul>
<b>7.2 MISA Monitoring</b> <ul style="list-style-type: none"> <li>Readers are referred to the MISA Monitoring Reports for data collected during the monitoring regulation.</li> </ul>

**Table 2.2**  
**Outline of Site Visit Reports**

<b>8.0 BEST MANAGEMENT PRACTICES</b>
<ul style="list-style-type: none"> <li>• Best management practices for the prevention of storm water contamination are described, including any documented training, prevention and clean-up procedures.</li> </ul>
<b>9.0 CONCLUSIONS</b>
<b>9.1 Follow-up Information</b> <ul style="list-style-type: none"> <li>• Any outstanding information requests are noted.</li> </ul>
<b>9.2 Site Observations</b> <ul style="list-style-type: none"> <li>• Any additional information available on the site is provided, including land area available and suitability of soils for construction, as well as size, length and slope of existing outfalls.</li> </ul>
<b>9.3 Future Projects</b> <ul style="list-style-type: none"> <li>• Any future projects related to or affecting wastewater management are noted.</li> </ul>
<b>10.0 SITE VISIT TEAM</b>

**Table 2.3**  
**Outline of BAT Option Reports**

<b>1.0 PLANT DESCRIPTION</b>
<ul style="list-style-type: none"> <li>• Brief description of products, processes and water and wastewater management.</li> </ul>
<b>2.0 WASTEWATER SOURCES AND QUALITY</b>
<ul style="list-style-type: none"> <li>• Brief description of wastewater sources, including description of MISA Control Points.</li> <li>• Summary of MISA data on flow, quality and loadings developed and presented in tables in the Appendix. Storm outfalls not included.</li> </ul>
<b>3.0 RATIONALE FOR SELECTION OF BAT OPTIONS</b>
<ul style="list-style-type: none"> <li>• BAT Options defined.</li> <li>• Detailed discussion of the rationale used in selecting BAT Options.</li> <li>• Toxicity data summarized in table in Appendix.</li> <li>• Summary table of BAT Options.</li> </ul>
<b>4.0 BAT OPTIONS</b>
<ul style="list-style-type: none"> <li>• Detailed description of technology, performance and costs of each BAT and BAT Option.</li> </ul>
<b>5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS</b>
<ul style="list-style-type: none"> <li>• Summary table.</li> </ul>
<b>6.0 REFERENCES</b>



### **Section 3**

## **SITE VISIT REPORTS**

Site Visit Reports for each of the 27 Ontario ICS plants are available from the Ontario Ministry of the Environment MISA Office.

Table 3.1 highlights pertinent information on each plant that influenced the selection of BAT Options.

**Table 3.1**  
**Overview of Inorganic Chemical Sector Plants**

Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Abrasives	Exolon ESK Company of Canada Ltd.	Fused aluminum oxide abrasives	<ul style="list-style-type: none"> <li>Contact cooling water is settled and recycled, and overflows are discharged.</li> <li>Control cooling water overflow and storm water were monitored at one MISA Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants in effluents include TSS and metals.</li> </ul>
	Norton Advanced Ceramics of Canada Inc.	Aluminum oxide products, alumina zirconas, chromic oxide and ferro- silicon.	<ul style="list-style-type: none"> <li>Contact cooling water is settled and recycled back to process. Overflows are discharged.</li> <li>Other discharges include treated effluents from two processes and storm water.</li> <li>Effluents were monitored at three MISA Control Points.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are generally non-lethal although some lethality was measured at one Control Point.</li> <li>Effluent contaminants include TSS, aluminum, other metals, oil and grease, mercury, chloroform and methylene chloride.</li> </ul>
	Washington Mills Limited	Aluminum oxide abrasives and ferro-silicon.	<ul style="list-style-type: none"> <li>Contact cooling water is settled and recycled, and overflows are discharged.</li> <li>Contact cooling water overflow and storm water were monitored at one MISA Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Effluent contaminants include TSS, sulphide, metals (with high levels of boron and strontium), chloride and sulphate.</li> <li>The raw groundwater used appears to be the source of TSS, strontium, boron, sulphide, sulphate and chloride.</li> </ul>
Aluminum chloride and sodium hypochlorite	Washington Mills Electro Minerals Corporation	Fused aluminum oxide and ferro- silicon.	<ul style="list-style-type: none"> <li>Contact cooling water is settled and recycled, and overflows are discharged.</li> <li>Contact cooling water overflows and storm water were monitored at two MISA Control Points.</li> </ul>	<ul style="list-style-type: none"> <li>Effluent are non-lethal.</li> <li>Effluent contaminants include TSS, metals, phenolics, and oil and grease.</li> </ul>
	Welland Chemical Ltd.	Aluminum chloride, sodium hypochlorite, and repackaged chlorine	<ul style="list-style-type: none"> <li>Two unlined, neutralization ponds are discharged in batches from the site.</li> <li>Once through cooling water are discharged at three MISA Control Point locations.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents from both ponds and all cooling water discharge points are lethal.</li> <li>Contaminants in effluents from the pond receiving wash water from the aluminum chloride plant include TSS, aluminum and other metals, phenolics, chlorinated volatile and extractable organics and chloride.</li> </ul>

Table 3.1 Overview of Inorganic Chemical Sector Plants				
Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Carbon black	Columbian Chemicals Canada Ltd.	Carbon black.	<ul style="list-style-type: none"> <li>Process wastewaters are recycled back to the process. Only storm water is discharged from this site.</li> </ul>	
	Cabot Canada Ltd.	Carbon black.	<ul style="list-style-type: none"> <li>All wastewater and storm water from the plant site pass through a treatment system that includes settling with chemical addition and sand filtration.</li> </ul>	<ul style="list-style-type: none"> <li>Effluent from treatment plant is non-lethal.</li> <li>Effluent contaminants include metals, TSS and sulphide.</li> </ul>
Carbon dioxide	Liquid Carbonic Inc., Courtright	Liquid carbon dioxide	<ul style="list-style-type: none"> <li>Only one MISA Control Point. Monitors once through cooling water, compressor condensate, wash water and roof runoff.</li> <li>Compressor condensate is treated by oil/water separation.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants in effluents include metals and oil and grease. Levels did not exceed those in intake water.</li> </ul>
	Liquid Carbonic Inc., Matland	Liquid carbon dioxide and dry ice.	<ul style="list-style-type: none"> <li>Only one MISA Control Point. Monitors once through cooling water, cooling tower blowdown, compressor condensate, floor drain runoff and storm water.</li> <li>Compressor condensate is treated by oil/water separation.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants in effluents include metals and oil and grease. Levels did not exceed those in intake water.</li> </ul>
Carbon Graphite	UCAR Carbon Canada Inc.	Graphite and carbon electrodes and carbon cathode blocks.	<ul style="list-style-type: none"> <li>Once through cooling water and storm water runoff are discharged at three MISA Control Points.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants in effluents include TSS, metals, oil and grease and phenolics.</li> </ul>
	ICI Canada Inc. (Cornwall)	Chlorine, caustic soda, or caustic potash, hydrochloric acid, sodium hypochlorite and chlorinated paraffins.	<ul style="list-style-type: none"> <li>Process wastewaters are generated in the cell room. A portion of these effluents are treated in a mercury removal system that includes sulphide precipitation, filtration and GAC adsorption.</li> <li>Cell room wastewaters are monitored at an in-plant Control Point. This stream combines with other plant discharges, primarily once through cooling water, to be monitored at a final effluent Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Final effluents are non-lethal.</li> <li>Contaminants in cell room and final effluents include TSS, metals, chlorinated volatile and extractable organics, dioxin and furan compounds and chloride. Organic contaminants are contributed from other undefined sources, in addition to the cell room.</li> </ul>

**Table 3.1**  
**Overview of Inorganic Chemical Sector Plants**

Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Cyanamide	Cyanamid Canada Inc., Niagara Falls	Calcium carbide, diamide lime, calcium cyanamide, desulphurization reagents.	<ul style="list-style-type: none"> <li>Raw water is stored in ponds, which also contain storm water runoff. Pond water is used as once through cooling water.</li> <li>Cooling water is discharged through three MISA Control Point locations.</li> <li>Process contaminants (cyanide and phenols) in effluents may be associated with storm water runoff or contaminated soil.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are generally non-lethal.</li> <li>Contaminants present include; cyanide TSS, metals phenolics and oil and grease.</li> <li>With the exception of phenolics and cyanide, levels are not significantly different from intake water.</li> </ul>
	Cyanamid Canada Inc., Welland	Dicyanodiamide, cyanamide solutions, phosphine, phosphine derivatives, electronic grade chemicals.	<ul style="list-style-type: none"> <li>A barometric condenser stream and effluent from a process wastewater sludge stream are the only two process wastewaters discharged.</li> <li>The final effluent MISA Control Point monitors the two combined process streams. Once through cooling water is monitored separately.</li> <li>Sludge pond effluents were also monitored at an in-plant MISA Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Final effluents are lethal.</li> <li>Both sludge pond and final effluent streams contain ammonia, TKN, oil and grease and phenolics.</li> </ul>
	Explosives Technology International (ETI)	Monomethylamine nitrate (MMAN), water gel explosives, ammonium nitrate/fuel oil explosives (ANFO).	<ul style="list-style-type: none"> <li>In general, process waters produced at the site are recycled. A small volume of flow is sent to an outdoor pond.</li> <li>Wastewaters discharged from the site through one Control Point include softener backwash effluents, once through cooling water and storm water.</li> <li>Solid process residuals are burned onsite with no provision for leachate or runoff control.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants in effluents include ammonia, nitrate, TKN, TSS and metals.</li> </ul>
Fibre Insulation	Partek Insulations Ltd.	Mineral wool insulation.	<ul style="list-style-type: none"> <li>All process wastewaters are recycled back to process.</li> <li>Only one small once through cooling water stream is discharged.</li> </ul>	<ul style="list-style-type: none"> <li>Once through cooling water stream is lethal.</li> <li>Only low levels of oil and grease are present. Toxicity is probably caused by chlorine residual, although no monitoring data was available.</li> </ul>



**Table 3.1**  
**Overview of Inorganic Chemical Sector Plants**

Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Hydrofluoric acid and chlorofluorocarbons	Allied Chemicals Canada Inc.	Hydrofluoric acid, Genitron™ chlorofluorocarbon refrigerants.	<ul style="list-style-type: none"> <li>The hydrofluoric acid plant wastewater stream is neutralized and settled with brine mud produced at General Chemical. Chlorinated water recycled, and overflow, monitored at a MISA Control Point, is sent to the soda ash settling basin at General Chemical.</li> <li>Genitron™ process wastewaters are collected in a sump, monitored at a MISA Control Point, and transferred to the soda ash settling basin at General Chemical.</li> <li>Spent hydrochloric acid scrubber water from the Genitron™ plant is monitored at a separate MISA Control Point, and transferred to General Chemical for use in their calcium chloride process.</li> </ul>	<ul style="list-style-type: none"> <li>Toxicity tests were not carried out during the MISA Monitoring program on effluents from Allied since they do not discharge directly to surface water.</li> <li>Hydrofluoric acid plant effluents contain TSS, metals, chloroform, methylene chloride, dioxin compounds, oil and grease, chloride, fluoride and sulphate.</li> <li>Both Genitron™ streams contain TSS, metals, halogenated volatile organic compounds, extractable organics, dioxin and furan compounds, chloride and fluoride.</li> </ul>
Nitrogen fertilizer manufacturing	Nitrochem Inc.	Anhydrous ammonia, nitric acid, ammonium nitrate liquor and prills, and nitrogen fertilizer solutions.	<ul style="list-style-type: none"> <li>Most contaminated process waters are collected and recovered in the production of liquid nitrogen fertilizer products.</li> <li>The plant attributes a large portion of the effluent nitrogen load to one process stream from the Hydrogen Plant.</li> <li>Effluents, including Hydrogen Plant process wastewater, cooling tower blowdown and other small non-process stream and storm water all discharge through one final effluent Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Effluent is lethal.</li> <li>Contaminants in effluent include process related pollutants (ammonia, nitrate, TKN), TSS, metals, phenolics, sulphide, volatile organic compounds, dioxins and furans, oil and grease and sulphate.</li> </ul>

**Table 3.1**  
**Overview of Inorganic Chemical Sector Plants**

Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Nitrogen fertilizer manufacturing (Cont'd)	ICI Nitrogen Products, Lambton Works	Anhydrous ammonia, urea, sulphur coated urea, ammonium nitrate prills and solution and liquid carbon dioxide	<ul style="list-style-type: none"> <li>Most contaminated process waters are collected and recovered in the production of liquid nitrogen fertilizer products.</li> <li>Some portion of the effluent ammonia and nitrate loading is from a barometric condenser effluent.</li> <li>Several in-plant streams were monitored, in addition to one final effluent. The final effluent includes once through cooling water, non-contact steam condensates, boiler and cooling tower blowdown wash water, water treatment wastewater and storm water runoff.</li> </ul>	<ul style="list-style-type: none"> <li>The final effluent is non-lethal.</li> <li>Contaminants in the final effluent include TSS, metals, ammonia, TKN and nitrate.</li> </ul>
	Union Carbide Linde Moore	Liquid and gaseous nitrogen	<ul style="list-style-type: none"> <li>Only one MISA Control Point. Monitors cooling tower blowdown and storm water runoff.</li> <li>Compressor condensate is reused as make-up water to cooling tower.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants present include TSS, metals, oil and grease, phosphorus and methylene chloride.</li> </ul>
	Union Carbide Linde Samla	Liquid and gaseous nitrogen	<ul style="list-style-type: none"> <li>Only one MISA Control Point. Monitors compressor condensate, cooling tower blowdown, other non-contact condensates and storm water runoff.</li> <li>Compressor condensate and wash water are treated by oil/water separation.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are lethal.</li> <li>Contaminants present include TSS, metals, oil and grease, phosphorus and two dioxin compounds.</li> </ul>
Nitrogen gas	Union Carbide Linde Sault Ste. Marie	Nitrogen, oxygen and oxygen gases	<ul style="list-style-type: none"> <li>Only one MISA Control Point. Monitors compressor condensate, cooling tower blowdown and storm water runoff.</li> <li>Compressor condensate is treated by oil/water separation.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are non-lethal.</li> <li>Contaminants present include TSS, metals, oil and grease, phosphorus, methylene chloride and two dioxin compounds.</li> </ul>

**Table 3.1**  
**Overview of Inorganic Chemical Sector Plants**

Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Nitrous oxide gas	Puritan-Bennett	Nitrous oxide.	<ul style="list-style-type: none"> <li>Only once through non-contact cooling water is discharged from the plant through a single Control Point.</li> <li>An onsite well provides plant raw water.</li> </ul>	<ul style="list-style-type: none"> <li>Toxicity data were not collected for effluents. However, effluent ammonia concentrations exceed toxic levels.</li> <li>Contaminants are at similar levels in raw water and effluents. These include ammonia, nitrate and TKN.</li> </ul>
	Albright and Wilson Americas	Phosphoric acid, sodium phosphate products, potassium phosphate products.	<ul style="list-style-type: none"> <li>All process waters are recycled back into the process for recovery of product.</li> <li>Only once through cooling water, water softener backwash water and boiler blowdown is discharged through a single MISA Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Effluents generally non-lethal although there were 19% lethal samples, attributed to residual chlorine.</li> <li>Contaminants in effluents include metals and TSS, chloroform and dibromochloromethane. Levels were not significantly different from intake water quality.</li> </ul>
	International Minerals and Chemical Corporation (Canada) Ltd.	Formerly produced phosphate fertilizers. Currently operations are shut down.	<ul style="list-style-type: none"> <li>Contaminated storm water from phospho-gypsum ponds and plant site is discharged after treatment by lime precipitation and settling.</li> </ul>	<ul style="list-style-type: none"> <li>Approximately half of effluent samples were non-lethal.</li> <li>Contaminants present in effluents include phosphorus, TSS, phenolics, metals, sulphide, fluoride and sulphate.</li> </ul>
Packaging plants	Sulco	Sulphuric acid production and packaging of other acids.	<ul style="list-style-type: none"> <li>Wastewater, primarily made up of wash water from packaging operations is treated in neutralization and settling ponds, and filtered through both filters.</li> <li>Process wastewater, are not discharged from the sulphuric acid manufacturing process</li> </ul>	<ul style="list-style-type: none"> <li>Effluents are generally non-lethal.</li> </ul>
	Compak, A Business Unit of ICI Canada Inc.	Packaging of compressed gases acids, and caustics.	<ul style="list-style-type: none"> <li>Wastewater, primarily made up of wash water from the packaging operations, is neutralized before being discharged in batches through a single Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Batch effluents are lethal.</li> <li>Effluent pollutants include pH, metals, TSS, volatile organic compounds, extractable organic compounds, chloride and sulphate.</li> </ul>

**Table 3.1**  
**Overview of Inorganic Chemical Sector Plants**

Category	Plant	Products	Wastewater Management	General Comments on Effluent Quality <sup>1,2</sup>
Soda ash calcium/chloride	General Chemical Canada Ltd.	Soda ash and calcium chloride.	<ul style="list-style-type: none"> <li>Salt slurry and brine sludges are all sent to the soda ash settling basin, where they are mixed with wastewater from Allied Chemicals. The settling basin discharges through a MISA Control Point.</li> <li>Barometric condenser effluents, once through cooling water storm water treatment plant effluents are combined and monitored at a second MISA Control Point.</li> </ul>	<ul style="list-style-type: none"> <li>Soda ash settling basin effluents were lethal and contain ammonia, TSS, metals, volatile organic compounds, chloride, fluoride and sulphate.</li> <li>The second MISA Control Point effluents were non-lethal, and contain TSS, metals and dioxin at similar levels of intake water. Other contaminants include ammonia, furan compounds, mercury and sulphide.</li> </ul>

**Notes:**

1. Effluent quality comments are based on data from the 12-month MISA Monitoring Regulation period. Comments on lethality are based on results of the first six months of period.
2. Lethality is defined as achieving 50 percent mortality of the test species (rainbow trout and *Daphnia magna*) in full strength effluent samples over the test duration.





## **Section 4**

### **BAT OPTION REPORTS**

Final BAT Option reports, are provided for the 27 Ontario ICS plants in the Appendixes 1 to 27. These reports present BAT options and their associated costs and performance recommended for each plant.

Tables 4.1 provides a general overview of the types of BAT options recommended for the Ontario plants.

**Table 4.1**  
**Summary of BAT Options Recommended for**  
**Ontario Inorganic Chemical Sector Plants**

Category	Plant	BAT Option 1	BAT Option 2	BAT Option 3	BAT Option 4	BAT Option 5
Abrasives	Exolon ESK	No change	Not defined	No change	MP	BAT Option 4
	Norton	No change	Not defined	No change	MP	MP Recycle <sup>7</sup>
	Washington Mills Electro Minerals Corp.	No change	Not defined	No change	MP	MP Recycle
	Washington Mills	No change	Not defined	No change	MP Alternate water source <sup>8</sup>	BAT Option 4
Aluminum Chloride	Welland Chemical	In-plant End-of-pipe	No change	No change	MP In-plant End-of-pipe	MP In-plant End-of-pipe Reuse
Carbon Black	Cabot Canada	No change	Not identified <sup>12</sup>	No change	SICS	SICS BAT Option 2
	Columbian Chemicals	No change	No change	No change	No change	No change
Carbon Dioxide	Union Carbide Linde Moore	No change <sup>1</sup>	No change	No change	No change	No change
	Union Carbide Linde Sarnia	TRS <sup>2</sup>	MP <sup>3</sup>	No change	No change	No change
	Union Carbide Linde Sault Ste. Marie	No change	No change	No change	No change	No change
Carbon graphite	UCAR Carbon Canada Inc.	No change	Not defined	No change	No change	No change
Chlor-alkali	ICI Forest Products	No change	End-of-pipe	No change	MP End-of-pipe Reuse	MP Process charge End-of-pipe Reuse
Cyanamide products	Cyanamid, Niagara Falls	No change	Not defined	No change	SICS <sup>10</sup>	BAT Option 4
	Cyanamid, Welland	In-plant End-of-pipe TRS	Not defined	No change	MP In-plant End-of-pipe	BAT Option 4
Explosives	ETI	No change	No change	No change	In-plant	In-plant
Fibre Insulation	Partek	Reuse <sup>11</sup>	No change	No change	No change	Reuse
HF/CFC	Allied Chemicals	Not identified	End-of-pipe	No change	In-plant End-of-pipe	In-plant End-of-pipe Recycle

**Table 4.1**  
**Summary of BAT Options Recommended for**  
**Ontario Inorganic Chemical Sector Plants**

Category	Plant	BAT Option 1	BAT Option 2	BAT Option 3	BAT Option 4	BAT Option 5
HF/CFC	Allied Chemicals	Not identified	End-of-pipe	No change	In-plant End-of-pipe	In-plant End-of-pipe Recycle
Nitrogen fertilizer	ICI Nitrogen Products	No change	In-plant	No change	In-plant <sup>9</sup> MP	BAT Option 4
	Nitrochem	In-plant End-of-pipe	In-plant End-of-pipe	No change	MP In-plant End-of-pipe	BAT Option 4
Nitrogen gas	Liquid Carbonic, Courtright	No change	Not defined <sup>4</sup>	No change	No change	No change
	Liquid Carbondic, Maitland	No change	Not defined	No change	No change	No change
Nitrous Oxide	Puritan Bennett	End-of-pipe	Not defined	No change	End-of-pipe <sup>5</sup> MP	BAT Option 4 <sup>6</sup>
Phosphorus products	Albright and Wilsons	End-of-pipe	Not defined	No change	No change	No change
	IMC	TRS	No change	No change	No change	No change
Packaging plants	Conpack, ICI	End-of-pipe	Not defined	End-of-pipe	MP End-of-pipe	BAT Option 4
	Sulco Chemicals	No change	No change	No change	SICS End-of-pipe	BAT Option 4
Soda ash	General Chemical	End-of-pipe Reuse	Not defined	No change	MP In-plant End-of-pipe Reuse	BAT Option 4

**Notes:**

1. No change - No change to the existing wastewater management system.
2. TRS - The source of toxicity was not identified. Therefore, a toxicity reduction study was recommended.
3. MP - Management practices for control of the discharge of target contaminants were recommended.
4. Not defined - A BAT Option could not be defined because there is no U.S. BAT.
5. End-of-pipe - End-of-pipe wastewater treatment.
6. BAT Option 4 - BAT Option 5 includes the same recommendations as BAT Option 4.
7. Recycle - Recycle of wastewater.
8. Alternate water source - Alternate raw water supply source.
9. In-plant - In-plant process changes or treatment.
10. Reuse - Reuse of treated effluent in plant.
11. SICS - The source of contamination could not be identified. Therefore a source identification and control study was recommended.
12. No identified - There was insufficient information available to identify the BAT Option.





## **VOLUME 2 - BAT OPTION REPORTS**



## TABLE OF CONTENTS

### Appendix

Albright & Wilsons Americas	1
Allied Chemicals Canada	2
Cabot Canada Ltd.	3
Columbian Chemicals Canada Ltd.	4
Conpak, A Business Unit of ICI Canada Inc.	5
Cyanamid Canada Inc., Niagara Falls	6
Cyanamid Canada Inc., Welland	7
Explosives Technology International (Canada)	8
Exolon ESK Company of Canada Ltd.	9
General Chemical Canada Ltd.	10
ICI Forest Products, Cornwall	11
ICI Nitrogen Products, Lambton Works	12
International Minerals and Chemical Corporation (Canada) Ltd.	13
Liquid Carbonic (Courtright)	14
Liquid Carbonic (Maitland)	15
Nitrochem Inc.	16
Norton Advanced Ceramics of Canada Inc.	17
Partek Insulations Ltd.	18
Puritan Bennett	19
UCAR Carbon Canada Inc.	20
Sulco	21
Union Carbide Linde, Morre	22
Union Carbide Linde, Sarnia	23
Union Carbide Linde, Sault Ste. Marie	24
Washington Mills Limited	25
Washington Mills Electro Minerals Corp.	26
Welland Chemical Ltd.	27





## **APPENDIX 1**

**Albright & Wilsons Americas**



# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### ALBRIGHT AND WILSONS AMERICAS

#### 1.0 PLANT DESCRIPTION

The Albright and Wilson Americas plant on Grand River at Lake Erie, produces phosphoric acid, in a dry furnace process, which is reacted with sodium and potassium salts to produce various industrial and food grade products. Raw water from Lake Erie that has been screened and chlorinated is used as once through cooling water, for cooling tower make-up, water softener backwash and ion exchanger regeneration. This water is softened for use as boiler make-up water, and deionized for use in the phosphoric acid product. Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Wastewater Sources

Wastewater generated within the plant, including cooling tower blowdown, wash water, product spills, spent anion exchanger regenerant, as well as storm water from plant production areas, are all recycled back into the process as scrubber liquor and in the production of sodium phosphate products through a lined lagoon collection system. None of these wastewaters are discharged from the site.

The only discharges from the production area include those which are not directly process related and include once through cooling water, water softener backwash water and boiler blowdown. This combined effluent was measured during the MISA Regulation Monitoring Period at Control Point CO0100.

Two other Control Points, ST0200 and ST0300, monitored surface runoff from non-production areas of the plant site. The plant also monitored intake water at IN0400 after the point of chlorination.

##### 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at Albright and Wilson Americas.



Raw water quality measured during the MISA monitoring period at Control Point IN0400 is presented in Table A2.

### 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for wastewater management, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

#### BAT Option 1

Toxicity data were collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment. Tests on rainbow

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

trout and Daphnia magna were carried out on samples taken at Control Point CO0100 and IN0400. These results are presented in Table A3.

Table A3 shows that most samples monitored at CO0100 were non-lethal to both of the test species. However, lethal concentrations of 78 to >100 percent were calculated for a few samples of both raw water and effluents. There is insufficient data to establish whether the effluent is more toxic to the test species than the raw water used at the plant.

The analytical data does not indicate the significant toxic levels of any contaminants. However, since toxicity was also measured in intake water samples, and the intake water is of similar quality to the effluent, the likely possibility is that residual chlorine has contributed to the toxic effects of both intake water and effluent samples. Chloroform and dibromochloromethane, measured in both intake water and effluent samples are trihalomethanes possibly resulting from raw water chlorination.

Based on the contaminant monitoring data and the fact that toxicity of both raw water and effluent samples was measured, chlorine residual is indicated as the likely cause of toxicity. Chlorine dosages or residual monitoring data were unavailable to confirm this conclusion.

To confirm residual chlorine as the cause of toxicity, it should be monitored in plant effluents. Based on the available data, BAT Option 1 incorporates dechlorination of effluents to reduce chlorine residuals, thus, making them non-lethal.

### **BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition) Part 18 - Fertilizer Manufacturing Phosphate Category, Part 422 Subpart C - Phosphate Subcategory, and Subpart F - Sodium Phosphates Subcategory, BAT limits were not defined for the production of phosphoric acid using the dry furnace process or for the production of sodium or potassium phosphates from dry process phosphoric acid. Furthermore, facilities were not identified in the U.S. or elsewhere that could be considered as "sister" plants, with similar product lines and production capacity. Thus, a BAT Option 2 was not identified.

### **BAT Option 3**

Albright and Wilson is the only plant of its kind in Ontario, and therefore, its existing wastewater management system is considered to be BAT Option 3.

## **BAT Option 4**

The existing process at Albright and Wilson results in the recycle and consumption of all process wastewater, including runoff from production areas. Therefore, BAT options that provide the maximum overall pollution reduction, or which advance the plant towards zero discharge, would be considered only for non-process streams discharged, including once through cooling water, boiler blowdown and water softener backwash water.

Boiler operations will introduce pollutants to the blowdown stream from system corrosion, and through the addition of water treatment chemicals. The available data indicates that corrosion of the boiler is not a problem. Copper was not a Priority 1 pollutant in effluents, and levels of other metals were not significantly different from intake water. Products used at the plant for controlling boiler operations include a sodium sulphite based oxygen scavenger and a polymer based dispersant. Neither compound contributes obvious toxicity to the final effluent.

Water softening operations contribute contaminants to backwash streams from the softener regenerant, sodium chloride. Technologies for removal of sodium chloride from backwash water were not identified. Furthermore, chloride levels in the final effluent were not significantly different than those in intake water.

It is important to note that several contaminants present in water softener backwash and boiler blowdown streams are not generated in the process. These are present in the raw water and concentrated on the ion exchange surface in the case of softening, and through evaporation, in the case of boiler operations. These contaminants, include TDS, nitrates, TSS, metals (Al, Sn, Zn and Hg), phosphorus, chloride, fluoride, and sulphate and oil and grease. Because the concentrated boiler and backwash streams are diluted with once through cooling water for final discharge, their concentrations are generally the same as those in intake water, as shown in Tables A1 and A2.

Technologies for the removal of these low levels of contaminants present in the combined effluent stream may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

## **BAT Option 5**

Technologies that would advance the plant further zero discharge by reducing or eliminating non-process streams were not identified, since these streams are invariably generated in the process, and opportunities for reducing or eliminating these streams by consumption or alternative technologies do not exist or are not feasible. With the exception of leaks, opportunities for the introduction of contamination through once

through cooling water operations do not exist. Chemicals are not added to the stream, and there is no contact with materials at the plant. BAT for leak identification involves routine monitoring of the cooling water stream, for contaminants that would indicate leaks, and this is already being carried out at the plant (Ref. 1). Thus, technologies beyond the existing, for BAT Option 5 were not identified.

## Summary

Table 1 summarizes BAT options for Albright and Wilson.

<p align="center"><b>Table 1</b> <b>Summary of BAT Options for Albright and Wilsons Americas</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	Dechlorination of final effluent stream.
2	U.S. BAT	No option defined.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum pollutant reduction	No change to existing system.
5	Furthest towards zero-discharge of pollutants	No change to existing system.

## **4.0      BAT OPTIONS**

BAT Option 1 is described in the following sub-section. Options 3 to 5 are the existing system, and Option 2 was not identified.

### **4.1      BAT Option 1**

#### Description

BAT Option 1 involves dechlorination of the final plant effluent stream, monitored at Control Point CO0100.

Dechlorination, by addition of sulphite compounds, removes free chlorine, monochloramine, dichloramine, nitrogen trichloride, and poly-n-chlor compounds. The system includes a chemical storage tank, feed pump, continuous dechlorination analyzer, dosage controller, pressure valves and feed lines. A schematic of the system is shown in Figure A1 and details are provided in the General Technology Report (Ref. 3).



## Performance

Zero chlorine residual is achievable with dechlorinating chemicals such as sodium metabisulphite and sulphur dioxide. Therefore, toxicity as a result of chlorine residuals is also eliminated.

## Costs

Capital costs of a dechlorination system to treat average effluent flows of 6,030 m<sup>3</sup>/d, as measured over the 12 months monitoring period at MISA Control Point CO0100, are \$162,900 (ENR CCI 6343)<sup>2</sup>.

Assuming an average chlorine residual of 6.0 kg/d (1 mg/L chlorine residual), operating costs are estimated at \$11,300 per year, including chemicals and labour.

## 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 2 summarizes the cost and performance estimated for implementation of BAT options.

Table 2 Summary of Estimated Cost and Performance of BAT Options		
Component	Estimated Result	
	BAT Option 1	Existing (BAT Options 3, 4 and 5)
Cost		
• Capital	\$162,900	0
• Operating	\$11,300/y	0
Performance <sup>1</sup>		
• Toxicity		
- Rainbow trout	non-lethal	>100% to non-lethal
- Daphnia magna	non-lethal	>80% to non-lethal

## 6.0 STORM WATER MANAGEMENT

Effluents monitored at Control Points ST0200 and ST0300 included storm water runoff from non-process areas of the plant. The collection area for ST0200 also covers an area where lagoons would overflow if their capacity were exceeded. Thus, contaminants in lagoon wastewater would runoff in storm water in an overflow event.

<sup>2</sup> Engineering News Record Construction Cost Index.



Lagoons have overflowed on occasion as a result of heavy rainfall.

Reducing the risk of lagoon overflow should be considered in the long-term management of storm water discharges at the plant. This would include:

- Cleaning out the existing volume of sludge build-up in the lagoons, which has reduced their storage capacity and subsequent regular routine clean-out, to maintain maximum storage capacity.
- Implementation of additional storage capacity, if required.

## 7.0 REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report - Albright & Wilson Americas. March 19, 1991 (unpublished).
2. Ontario Water Quality Guidelines. Ontario Ministry of the Environment, 1984.
3. General Technology Report - Dechlorination.



## **APPENDIX**

### **Tables and Figures**



**Table A1, Albright and Wilson Americas**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: Final Discharge

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0.992	7850	6030	
Nitrate and Nitrite	mg/L	0.189	1.05	0.37	2.297
DOC	mg/L	1.7	31	3.4	20.904
Total Phosphorus	mg/L	0.01	2.67	0.09	0.528
Specific Conductance	uS/cm	222	557	328	
Total Suspended Solids	mg/L	0.5	66	5.6	33.595
Aluminum	ug/L	9.7	100	583	3.522
Strontium	ug/L		66	181	1.124
Zinc	ug/L	3	15	7.3	0.046
Mercury	ug/L	0.05	0.7	0.13	0.001
Phenolics (4AAP)	ug/L	0.6	10.2	3.8	0.024
Dibromochloromethane	ug/L	2.7	3.4	3.05	0.022
Chloroform	ug/L	3.7	5.4	4.55	0.032
Oil and Grease	mg/L	1	5	1.2	7.279
Chloride, Unfiltered Reactive	mg/L	18.1	27	22.6	164.601
Fluoride, Unfiltered Reactive	mg/L	0.12	0.14	0.13	0.938
Sulphate, Unfiltered Reactive	mg/L	24	39	31.5	230.802



**Table A2, Albright and Wilson Americas****Summary of Flows and Priority One Pollutants****MISA Control Point: IN0400****Description: Intake**

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
Flow	m3/d			
Nitrate and Nitrite	mg/L	0.18	1.02	0.36
DOC	mg/L	1.7	6.6	2.8
Specific Conductance	uS/cm	211	548	306
Total Suspended Solids	mg/L	0.5	48	5.04
Aluminum	ug/L		5600	504
Strontium	ug/L		230	174
Zinc	ug/L	3	27	12.7
Mercury	ug/L	0.06	0.9	0.1
Dibromochloromethane	ug/L	2.7	3.6	3.2
Chloroform	ug/L	4.1	4.5	4.3
Oil and Grease	mg/L	1	4	1.2
Chloride, Unfiltered Reactive	mg/L	16.9	23	20
Fluoride, Unfiltered Reactive	mg/L	0.12	0.14	0.13
Sulphate, Unfiltered Reactive	mg/L	23	34	28.5

**Table A3**  
**Toxicity Testing Results at Albright & Wilson Americas**

Stream	Species	No. of Samples	Range of Data	Number of Non-Lethal Samples
CO0100	Rainbow Trout	7	>100% non-lethal	4
	<u>Daphnia magna</u>	7	80.6% to non-lethal	6
IN0400	Rainbow Trout	6	all non-lethal	6
	<u>Daphnia magna</u>	6	77.9% to non-lethal	5

**Albright & Wilson**  
**Port Maitland**

		CONCENTRATIONS				LOADINGS (kg/d)	
ATG	PARAMETER	RMDL	UNIT	CO 0100	IN 0400	CO 0100	IN 0400
c	Total suspended solids	5	mg/L	4.45	3.75	26.7	22.7
c	Hydrogen ion (pH)			7.96	7.76		
c	Specific conductance		uS/cm	327	305		
c	DOC	0.5	mg/L	3.39	2.82	20.9	17
c	TOC	5	mg/L	3.43	2.81	21.2	17
c	Oil and grease	1	mg/L	1.21	1.25	7.28	7.56
c	Ammonia plus Ammonium	0.25	mg/L	0.031	0.03	0.193	0.181
c	Nitrate + Nitrite	0.25	mg/L	0.37	0.355	2.3	2.15
c	Total Kjeldahl nitrogen	0.5	mg/L	0.242	0.241	1.52	1.46
c	Total phosphorus	0.1	mg/L	0.081	0.058	0.484	0.351
09	Aluminum	30	ug/L	583	504	3.52	3.05
09	Strontium	20	ug/L	181	175	1.12	1.06
09	Zinc	10	ug/L	7.33	12.7	0.046	0.077
12	Mercury	0.1	ug/L	0.126	0.099	0.001	0.001
14	Phenolics (4AAP)	2	ug/L	3.83	1.36	0.024	0.008
16	1,2-Dichloroethane	0.8	ug/L	0.665	0.665	0.005	0.004
16	Chloroform	0.7	ug/L	4.55	4.3	0.032	0.026
16	Dibromochloromethane	1.1	ug/L	3.05	3.15	0.023	0.019
16	Methylene chloride	1.3	ug/L	14	1.21	0.109	0.007
17	Benzene	0.5	ug/L	0.7	1.25	0.005	0.008
23	Hexachlorocyclopentadiene	10	ng/L	11.7	7.45	—	—
98	Ftflow		m3/d	6050			
11	Chloride	2	mg/L	22.6	20	165	121
12	Fluoride	0.1	mg/L	0.130	0.130	0.938	0.786
13	Sulphate	5	mg/L	31.5	28.5	231	172

Notes:

CO0100 is the "Final Discharge to the River" which discharges into Lake Erie.

Intake loadings are based on reported concentrations and the mean discharge flow rate.

## **APPENDIX 2**

**Allied Chemicals Canada**





# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### ALLIED CHEMICALS CANADA LTD.

#### 1.0 PLANT DESCRIPTION

Allied Chemicals Canada Ltd. located near Amherstburg, Ontario manufactures hydrofluoric acid and chlorofluorocarbons. Hydrofluoric acid gas evolved by the reaction of fluorspar, oleum and sulphuric acid in a furnace, is condensed, distilled to remove impurities and stored or diluted with water for sale. A portion of hydrofluoric acid is used in the manufacture of chlorofluorocarbons, under the trade name Genetron™. Hydrofluoric acid is reacted with carbon tetrachloride or chloroform in batch, and reactor contents are compressed, distilled and condensed to produce various Genetron™ refrigerants.

Water from the Detroit River, supplied from General Chemical Canada Ltd.<sup>1</sup>, is used in the plant for cooling, as scrubber water, and for other general uses such as washdown. In addition, potable water from a treatment plant at General Chemical is used as cooling tower make up water.

Details on the plant, processes and wastewater management methods are presented in the site visit report (Ref. 2).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Wastewater Sources

Gypsum residue from the hydrofluoric acid process is slurried with water and neutralized with alkaline calcium and magnesium carbonate sludges (brine muds) from General Chemical. Solids are removed in a settling pond and pond water is recycled back to serve as slurry water. Overflows from the pond, monitored during the MISA Monitoring Regulation period at PR0300, were discharged to a settling lagoon (soda ash settling basin) on the General Chemical property. This lagoon discharges to the Detroit River.

Two wastewater streams are also generated in the Genetron™ process. Hydrochloric acid scrubber water, produced when hydrochloric acid byproduct is stripped of chlorofluorocarbon gas, is sent to the calcium chloride process at General Chemical. The acid stream, combined with General Chemical soda ash plant effluents, is processed for the recovery of calcium chloride. The scrubber water stream was monitored at MISA Control Point PR0600.

---

<sup>1</sup> General Chemical Canada Ltd., produces soda ash and calcium chloride, and is located on the same site (Ref. 1).

The second Genetron™ wastewater stream includes wash water, spills, etc. from the process areas that are collected in a contaminant sump to allow appropriate treatment or spill recovery before being discharged via MISA Control Point PR0100 to the soda ash settling basin at General Chemical Canada Ltd.

Storm water from an onsite quarry and from one area of the plant were also monitored during the MISA Monitoring Regulation period. Much of the storm water runoff from the Allied site, was monitored by General Chemical at their North Drain Control Point CO0100.

## 2.2 Wastewater Flows and Quality

Tables A1, A2 and A3 in the Appendix present mean, maximum and minimum flow and concentration data for those parameters defined as "Priority 1" by the Ministry of the Environment for MISA Control Points PR0100, PR0300 and PR0600. Table A4 presents intake water quality data.

At the time this report was prepared, MISA monitoring data as presented in Table A1, was not yet verified by the Ministry. Since that time, corrections have been made, and the finalized data are presented in Table A5, for completeness. It is important to note that recommendations for BAT Options were made based on unverified data, and in a limited number of cases, may not be applicable based on corrected data results.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for the management of wastewater, with the exception of storm water runoff<sup>2</sup>, should be considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.

---

<sup>2</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control study at each site.

- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed the following discussions.

Individual BAT Options were considered for two distinct operating scenarios, as follows:

**Scenario 1** - General Chemical and Allied Chemicals continue to manage wastewater interactively. Thus, all of the wastewaters generated at Allied are discharged from General Chemical's site, and none are discharged directly to receiving water from Allied Chemicals.

All wastewater streams discharged from Allied Chemicals monitored in the MISA program eventually leave the General Chemical site after being settled in a settling basin. BAT options that address this discharge stream were considered when addressing options for General Chemical's effluents (Ref. 5).

There was however, a need to identify BAT options for this scenario at Allied that address a few contaminants discharged from Allied Chemicals. These contaminants were mostly not detected in General Chemical's effluents, but were considered because there are no processes intended for their removal after the MISA monitoring points at Allied Chemicals. Thus, they may be transferred to other environmental media, incorporated into General Chemical's product, or simply not detected in General Chemical effluents as a result of dilution. However, because they originate at Allied Chemicals, BAT options for Scenario 1 consider these contaminants.

**Scenario 2** - In this case, it is assumed Allied Chemicals would operate independent of General Chemical. Therefore, wastewater from General Chemical (i.e. brine muds) would not be available for neutralizing effluents, and all wastewater generated at Allied would be discharged directly to the receiving water. Therefore, BAT options for these effluents were considered.

### **3.1 BAT Option 1**

#### **Scenarios 1 and 2**

Toxicity tests were not conducted on Allied Chemical's effluents under the MISA Monitoring Regulation. Therefore, the acute toxicity of effluents to the test species rainbow trout and Daphnia magna are unknown.

A review of the data in Table A1, A2 and A3 indicates that several contaminants in Allied effluents are at levels that could contribute to toxicity. BAT Option 4 addresses the reduction of all of these contaminants. Since the toxicity contribution from each has not been defined, the minimum level of effort (i.e. least cost method) of achieving non-lethal effluents cannot be specified at this time.

## 3.2 BAT Option 2

### 3.2.1 Hydrofluoric Acid Plant

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), Part 415 Inorganic Chemicals Manufacturing, subpart H - Hydrofluoric Acid Production Subcategory, BPT and BAT effluent limits were defined for TSS, pH, fluoride, nickel and zinc. These limits are compared to the hydrofluoric acid pond overflow (bleed) stream effluent quality measured at MISA Control Point PR0300 in Table 1.

### Scenario 1

The data in Table 1 shows that the wastewater management system currently used by Allied generally produces an effluent quality that exceeds U.S. BPT and BAT requirements. Therefore, on a wastewater quality basis, no changes to the existing system are required.

<b>Table 1</b> <b>Comparison of U.S. BPT and BAT Limits to Allied Chemicals Effluents from Hydrofluoric Acid Manufacturing</b>				
Parameter	U.S. EPA Limits		Allied HF Bleed (PR0300)	
	30 Day Average	Maximum Day	12 Month Mean	12 Month Maximum <sup>5</sup>
Fluoride <sup>2</sup> (kg/d)	228	484	76.8	157
Nickel <sup>2</sup> (kg/d)	0.85	2.9	1.1	2.9
Zinc <sup>2</sup> (kg/d)	3.13	10.3	1.4	9.8
pH <sup>3</sup>	6.0-9.0	6.0-9.0	6.0-9.0	2.8-9.6 <sup>6</sup>
TSS <sup>3</sup> (kg/d)	755	1567	153	838
<b>Notes:</b> 1. Based on limits set on a kg/t of HF produced basis, and using reported Allied production rates. 2. U.S. BAT 3. U.S. BPT 4. Data from MISA Control Point PR0300. 5. Calculated using maximum concentration and mean flow. 6. Less than 2 percent of the total number of samples had pH values outside the neutral range.				



U.S. BAT limits were based on the treatment of slurried gypsum effluent with lime precipitation, settling/thickening and pH adjustment. In addition, U.S. BAT included the requirement of 65 percent effluent reuse for kiln residue slurring (Ref. 3, Ref. 1). At Allied Chemicals, alkaline brine muds from the settling of brine impurities at General Chemical is used to precipitate and neutralize kiln residue slurries. The recycle rate utilized is estimated to be 66 percent of the gypsum slurry wastewater production rate.

Based on the above discussion neutralization of hydrogen fluoride plant effluents using brine muds can be considered at least an equivalent technology to lime treatment for treating Allied Chemicals hydrofluoric acid plant effluents. Therefore, no changes to the existing wastewater management system in Scenario 1 are included under BAT Option 2.

## Scenario 2

In this Scenario, brine muds would not be available for neutralizing the hydrogen fluoride plant effluents. The use of lime, as recommended by the U.S. EPA, could be used as the neutralizing agent, and would likely produce the same effluent quality. This alternative is recommended in Scenario 2 under BAT Option 2 and is discussed further in Section 4.

### 3.2.2 Genetron™ Manufacturing

Effluent regulations for chlorofluorocarbon manufacturing are covered under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), Part 44 Organic Chemicals, Plastics and Synthetic Fibre Manufacturing, subpart G, Bulk Organic Chemicals. Best practicable technology (BPT) limits were defined for effluent concentrations of BOD<sub>5</sub>, TSS and pH. BAT concentration limits for toxic contaminants were set for plants both with and without end-of-pipe biological wastewater treatment.

Table 2 presents a comparison of U.S. BPT and BAT limits to Genetron™ effluents at Allied Chemicals. In general, conventional contaminants and volatile organic compounds detected in effluents were at levels significantly exceeding those defined by the U.S. EPA.

## Scenario 1

In the existing Scenario, Genetron™ plant wastewaters are currently handled further at General Chemical before being discharged. Although only a few of these volatile organics were detected in General Chemicals discharges, and these were at levels and loadings significantly lower than in Allied Chemical's discharges, the handling of Genetron wastewaters at Allied Chemicals does not incorporate technologies for volatile organics removal. It is likely that although some natural destruction may occur, contaminants levels are lower because of dilution with other effluents, and also through evaporation to the atmosphere.



Neither evaporation nor dilution effects mitigate the discharge of volatile organics from Allied Chemicals to the Environment. Therefore, methods for reducing these chemicals in Allied Chemicals' Genetron™ effluents were addressed in BAT Option 2.

**Table 2**  
**Comparison of U.S. BPT and BAT Limits to Allied Chemicals Effluents from the Genetron™ Plant**

Parameter	U.S. Limits		Allied Effluents			
			PR0100 Genetron™ Sump <sup>1</sup>		PR0600 Hydrochloric Acid Scrubber <sup>2</sup>	
	Monthly Average	Daily Maximum	12 Month Mean	12 Month Maximum	12 Month Mean	12 Month Maximum
pH	6.0-9.0	6.0-9.0	8.7	1.2-12.8	2.5	0.1-7.8
BOD <sub>5</sub> (mg/L)	34	92	n.d. <sup>3</sup>	n.d.	n.d.	n.d.
TSS (mg/L)	49	159	224	77,000	n.p. <sup>4</sup>	n.p.
Acrylonitrile (µg/L)	94	232	577	1,050	15,000	21,500
Benzene (µg/L)	57	134	92	420	2,470	8,600
Chlorobenzene (µg/L)	142	380	103	420	2,610	8,600
1,2-Dichloroethane (µg/L)	180	574	92	420	2,610	8,600
1,1,2-Trichloroethane (µg/L)	32	127	125	420	2,880	8,600
Chloroform (µg/L)	111	325	4,610	120,000	15,500	700,000
1,2-Dichlorobenzene (µg/L)	196	794	246	1,050	6,390	21,500
1,3-Dichlorobenzene (µg/L)	142	380	286	1,260	7,560	25,800
1,4-Dichlorobenzene (µg/L)	142	380	425	2,100	12,000	43,000
1,1-Dichloroethylene (µg/L)	22	60	114	420	2,740	8,600
1,2-trans-Dichloroethylene (µg/L)	25	66	114	420	2,740	8,600
1,2-Dichloropropane (µg/L)	196	794	92	420	2,470	8,600
1,3-Dichloropropylene (µg/L)	196	794	591	2,520	15,340	51,600
Methylene chloride (µg/L)	36	170	389	13,000	18,500	580,000
Hexachlorobutadiene (µg/L)	142	380	205	500	5,220	50,000
Bis (2-ethylhexyl) phthalate (µg/L)	95	258	16	45	14	19
Tetrachloroethylene (µg/L)	52	164	136	420	3,010	8,600
Toluene (µg/L)	28	74	102	2,580	2,360	8,700
Trichloroethylene (µg/L)	26	69	235	1,050	6,250	21,500
Vinyl chloride (µg/L)	97	172	192	430	3,680	8,600
Chromium (µg/L)	1,110	2,770	29	70	52	140

**Table 2**  
**Comparison of U.S. BPT and BAT Limits to Allied Chemicals Effluents from the Genetron™ Plant**

Parameter	U.S. Limits		Allied Effluents			
			PR0100 Genetron™ Sump <sup>1</sup>		PR0600 Hydrochloric Acid Scrubber <sup>2</sup>	
	Monthly Average	Daily Maximum	12 Month Mean	12 Month Maximum	12 Month Mean	12 Month Maximum
Copper (µg/L)	1,450	3,380	15	60	n.p.	n.p.
Nickel (µg/L)	1,690	3,980	n.p.	n.p.	n.p.	n.p.
Zinc (µg/L)	1,050	2,610	71	1,070	55	110
Notes: 1. Data from MISA Control Point PR0100. 2. Data from MISA Control Point PR0600. 3. No data. 4. Not a "Priority 1" pollutant.						

Demonstrated processes identified for the removal of volatile organics include:

- Activated carbon adsorption
- Steam stripping
- Air stripping.

**Activated Carbon Adsorption:** Activated carbon systems, involving continuous flow columns containing granular activated carbon, are widely used for organics removal from wastewater. Activated carbon is a highly porous material resulting in a large surface area per volume ratio. Molecules are adsorbed to this surface, and the adsorption efficiency is dependent on a number of factors including the characteristics of the carbon, pollutant molecules, wastewater, and presence of competing molecules.

Removal efficiencies for volatile organics achievable in activated carbon systems can be calculated theoretically based on the adsorptive characteristics of each molecule and the media. However, actual efficiency depends on the relative absorbability of each organic compound. Removal efficiencies of up to >99 percent have been reported for many of the volatile organics present in Allied Chemicals Genetron™ wastewater.

Requirements of activated carbon systems include upstream TSS removal, to avoid fouling of the media and the need for frequent backwashing. Exhausted media may be disposed, or thermally regenerated, either onsite or by the media supplier. Generally, this regeneration destroys the toxic contaminants, so that safe ultimate disposal of the contaminant is achieved.

**Steam Stripping:** Steam stripping involves introducing steam at the bottom of a packed column, or bubble sieve plate tower. Steam flows counter current to the wastewater laden with volatile organics and because of the volatility of these pollutants, they become entrained in the steam and are removed from the wastewater. The small volume of steam condensate containing concentrated pollutants may be used for recovery of pollutants, or requires disposal.

Steam stripping involves relatively high operating costs, and is most effective and therefore, most commonly used, to recover valuable components from wastewaters. Steam stripping for volatile organics removal was considered at one "sister" chlorofluorocarbon manufacturing facility in the U.S., but rejected because there was no potential for recovery of the relatively small quantities of valuable components in the wastewater (Ref. 3). Steam stripping was not considered further for treatment of Allied Chemicals' Genetron<sup>TM</sup> process effluents.

**Air Stripping:** Air stripping is essentially a gas transfer process, in which the wastewater containing volatile pollutants is brought in contact with air and the pollutants transfer from the liquid to gas phase. Similar to steam stripping, a packed column is used to maximize the air to wastewater contact.

A major environmental consideration associated with air stripping of volatile organics is the transfer of pollutants to an air effluent. At one "sister" chlorofluorocarbon manufacturing plant in the U.S., air emissions released sufficiently low concentrations that air controls were not required (Ref. 3). To reduce the emissions of volatile organic compounds to air, air effluent collection and treatment by activated carbon adsorption or other air treatment technology may be utilized.

Both granular activated carbon (GAC) adsorption and air stripping, followed by GAC or other treatment of air emissions are technologies applicable to reducing levels of volatile organics in Allied Chemicals' Genetron<sup>TM</sup> effluents to less than those defined under U.S. BAT regulations.

Air stripping is a demonstrated technology for reducing volatiles in chlorofluorocarbon manufacturing process wastewaters. However, experience indicates the pH control is required to avoid corrosion or scaling of the stripping equipment, and settling is required, to avoid plugging of the packed column (Ref. 3). Furthermore, GAC adsorption or some other treatment of air emissions would be necessary to reduce the transfer of the pollutants to the atmosphere.

If air stripping were implemented at Allied Chemicals, neutralization of the acidic hydrochloric acid scrubber water stream would be required. This neutralization would likely release carbon dioxide gas and vapours containing volatile organics, which would also require GAC adsorption.



Implementation of GAC adsorption of Genetron™ sump wastewaters (PR0100) may also be considered for Allied Chemicals. In this case, the Genetron™ sump stream would need to be treated to reduce TSS removal to avoid fouling of the carbon.

Because of the reduced complexity of the system, granular activated carbon adsorption is recommended under BAT Option 2 for both Genetron™ effluents. Based on the present practice of reuse of the hydrochloric acid stream for the production of calcium chloride at General Chemical, the two process streams are not mixed. The system treating Genetron™ wastes will include settling and GAC adsorption, while the system treating the hydrochloric acid stream will include only GAC adsorption. Details of these systems are discussed in Section 4.0.

## **Scenario 2**

If Allied Chemicals were to discharge wastewaters directly, settling of the Genetron™ sump stream (PR0100) and GAC treatment of both streams, as described for Scenario 1, would be required to meet U.S. BAT limits for volatile organic compounds. In addition, adjustment of the pH of both streams would be required for U.S. BAT. Therefore, BAT Option 2 in Scenario 2 also includes mixing of the two carbon treated streams and chemical addition to achieve neutral pH.

## **3.3      BAT Option 3**

### **Scenarios 1 and 2**

Allied Chemicals Canada Ltd. is the only manufacturer of hydrofluoric acid in Ontario. Therefore, changes to the existing wastewater management system are not recommended under BAT Option 3.

In addition to Allied Chemicals, Dupont Canada in Maitland, Ontario, produces chloro-fluorocarbons, as well as a wide range of other organic chemical products. The wastewaters generated from all processes at the Dupont site are combined and biologically treated for removal of organic carbon. This technology is not applicable to the two Genetron™ streams generated at Allied because the very low organic carbon concentrations could not support biological treatment system. Furthermore, in plant recovery or recycle of wastewater streams (e.g. hydrochloric acid scrubber water) is not practiced at Du Pont. Thus, for the purposes of demonstrating best technologies in Ontario, applicable technologies at comparable facilities for managing Allied's Genetron™ process effluents were not identified. Therefore, changes to the existing system are not recommended under BAT Option 3.

### 3.4 BAT Option 4

BAT Option 4 includes technologies that provide the maximum level of contaminant removal from Allied Chemicals effluents. These technologies are discussed with respect to Scenario 1 and Scenario 2.

#### 3.4.1 Hydrofluoric Acid Plant

##### Scenario 1

In Scenario 1, hydrofluoric acid plant effluents treated at Allied Chemicals are ultimately transferred for additional treatment in a settling basin at General Chemicals' site before discharge. Furthermore, under BAT Option 4 specified for General Chemical (Ref. 5), the settling pond effluent stream would be treated for total dissolved solids (TDS) removal in a brine concentrator, and treated effluents would be available for recycle in the plant. Thus, there would be no discharge of wastewater from the settling pond.

Although zero-discharge of wastewater contaminants would result, removal of certain contaminants from Allied Chemicals effluents was considered in BAT Option 4 to prevent their discharges to the environment, for example, in air emissions or solid waste. These contaminants include:

- Volatile organic compounds
- Bis (2-Ethyhexyl) phthalate
- Dioxin compounds

**Volatile Organic Compounds:** Two volatile organic compounds, chloroform and methylene chloride, were detected at low levels in the hydrofluoric plant effluents. These contaminants may be associated with the chlorofluorocarbon manufacturing process, storm water runoff, or the chlorinated water supply used as cooling tower make-up water. Because the concentrations of these contaminants are low, a source identification and control study is not warranted. Furthermore, demonstrated technologies practical for treating the low levels of these contaminants in industrial wastewaters were not identified in a global search.

**Bis (2-Ethylhexyl) Phthalate:** One extractable trace organic compound, bis (2-ethylhexyl) phthalate, was detected in the hydrofluoric acid plant effluents. A review of the raw materials and chemicals used at the plant indicate that this contaminant is not likely process related. Because it is often detected as a result of analytical laboratory contamination, the true presence of this contaminant should be confirmed. However, because concentrations are low, no technologies for removal are recommended under BAT Option 4.

**Dioxins:** Dioxins are not likely associated with the hydrofluoric acid process at Allied Chemicals or the soda ash or calcium chloride processes at General Chemical which

discharge through Control Point PR0300. However, the Genetron™ process, which discharges wastewaters through MISA Control Points PR0100 and PR0600, appears to be a source of dioxin compounds. In the existing wastewater management system, opportunities for mixing of hydrofluoric acid plant streams with Genetron™ streams do not appear to exist. Thus, the likely source of these compounds in hydrofluoric acid plant effluents may be stormwater runoff, with the source of contamination being the Genetron™ area. Control of these contaminants from being released in Genetron™ effluents (to be discussed) will likely also address their elimination from hydrofluoric acid plant effluents.

## **Scenario 2**

In the case where Allied Chemicals would discharge wastewaters directly, maximum reduction of all "Priority 1" pollutants in the hydrofluoric acid plant effluents (PR0300) need to be considered. In addition, because brine muds from General Chemical would not be available for neutralization, an alternate neutralizing agent such as lime, as described under BAT Option 1, would be required. It is assumed that lime treatment using brine muds under Scenario 1 will produce an effluent of similar quality to the measured quality at PR0300. Contaminants present in the lime treated effluent include:

- Phosphorus
- TSS
- Metals
- Oil and Grease
- Chloride, fluoride and sulphate
- Volatile organic compounds
- bis (2-Ethylhexyl) phalate
- Dioxin compounds.

**Organic Compounds:** Methods for reducing these the first five contaminants above are discussed below. The discussion of removal of the three organic contaminant groups addressed under Scenario 1 also applies to Scenario 2.

**Phosphorus:** Phosphorus is likely contributed in part from phosphorus based chemicals used to treat cooling tower make-up water. Reduction of phosphorus could be achieved by using alternate treatment chemicals. However, because these would also contribute contaminants to effluents, there may not be an overall improvement in water quality. Therefore, water treatment chemical changes are not recommended. Phosphorus levels in effluents average less than 0.6 mg/L, and practical technologies for further removal of phosphorus in industrial effluents were not identified.

**TSS:** Total suspended solids levels of 25 mg/L in effluents were typical of those achievable in settling pond systems and were not significantly different from intake water (Table A4). Additional solids removal could likely be achieved through effluent filtration. However, a chemical coagulant may be required to improve filterability of solids



and achieve a significant improvement in removal efficiency. Thus, if chemical treatment were used, offsite disposal of chemical sludges would be required.

Because TSS levels are similar to intake water and there are potential negative environmental impacts associated with chemical addition and sludge removal, additional TSS treatment was not recommended.

**Metals:** One source of metals in final effluents is the raw water used at the plant, which contains similar levels of aluminum and zinc. Other sources may include impurities in the raw materials used in the production of hydrofluoric acid, and in brine impurities contained in the brine muds used to neutralize the hydrofluoric acid plant wastewaters. The source of some metal contaminants, particularly high levels of boron and strontium, have not been identified.

Arsenic and antimony are compounds that are typical of hydrofluoric plant effluents and originate from raw materials (Ref. 4). Information on whether the use of an alternative raw material source could be used to reduce contaminant levels was not identified.

A large portion of molybdenum is likely originating from water treatment chemicals used in cooling tower make-up water. This chemical has recently been implemented, to mitigate environmental impacts associated with chromium based treatment chemicals (Ref. 2). Alternatives to molybdate based chemicals may exist, and could be investigated for reduction of molybdenum in final effluents. However, all treatment chemical alternatives will still result in addition of contaminants to effluents. Since there is no clear advantage to using other treatment chemicals, no changes are recommended under BAT Option 4.

Demonstrated technologies for the removal of dilute levels of most metal contaminants (Al, Cd, Cu, Mo, Ni, Zn, As, and Sb) from industrial wastewater were not identified in a exhaustive global search. Furthermore, technologies used specifically for the removal of strontium and boron from industrial effluents were not identified. Chemical coagulation and flocculation technologies may be available for removing these metals. However, the negative environmental impacts associated with this type of treatment outweigh the benefits of removal.

The source of mercury in effluents is unknown; however, a review of materials used at General Chemical and Allied Chemicals did not suggest that plant operations are a source of these contaminants. A pollution prevention approach, involving an audit of pollutant sources and implementation of source controls, is recommended for reduction of mercury. Since low levels of mercury were measured in effluent streams discharged from Allied Chemicals and General Chemical, it is likely that these pollutants are contributed from storm water, and therefore, the main focus of the audit should be within a Storm Water Control Study. Demonstrated industrial wastewater treatment technologies for removal of mercury at the dilute concentrations present in General Chemical effluents were not identified in a global search.

**Oil and Grease:** Oil and grease was present at low levels (4 mg/L) in the hydrofluoric acid pond overflow stream (PR0300). Oil and grease may be contributed from a variety of sources, including storm water runoff and leaks and spills of oil used for equipment lubrication. Best management practices are recommended for control of oil and grease discharges inside the plant. In addition, implementation of controls for oil and grease contribution storm water should be included in a Storm Water Control Study.

**Chloride, Fluoride and Sulphate:** Based on current operation, the primary source of chloride in the hydrofluoric acid pond bleed stream is likely the brine muds used for neutralization. In Scenario 2, where Allied Chemicals would operate independently of General Chemical, lime would be used for neutralization. Under this scenario chloride levels would be similar to those in intake water and therefore, chloride reduction would not be necessary in this scenario.

Both fluoride (12.2 mg/L) and sulphate (2,020 mg/L) originate from the hydrofluoric acid furnace process. These contaminants are treatable using the following total dissolved solids removal technologies:

- Preconcentration of the waste stream using reverse osmosis, ion exchange or electrodialysis. Flow rates of residuals requiring further treatment will total approximately 10 to 30 percent of the original flow.
- Further concentration of the waste stream through evaporative technologies such as vapour compression evaporation or steam-driven evaporation.
- Crystallization of the concentrated waste stream through the use of spray dryers or equivalent technologies.
- Disposal of resulting solid wastes.

Preconcentration technologies require careful control of operating conditions to avoid fouling or deterioration of membranes or resins and may require additional pretreatment steps such as removal of solids and/or organics. All of these technologies are both energy and labour intensive. These added operational and technological complexities are not likely to be offset by the improvements in wastewater quality which would result at Allied Chemicals. Furthermore, other demonstrated technologies for the treatment of these contaminants at similar levels in industrial wastewaters were not identified. Thus, BAT Option 4 does not include measures for further control of dissolved solids such as fluorides and sulphates.

**Scenario 1**

Where Genetron™ process effluents are transferred to General Chemical, the hydrochloric acid scrubber stream would continue to be used by General Chemical in the production of calcium chloride. Effluents from the calcium chloride process, in addition to the Genetron™ sump effluents are settled in the soda ash settling basin. Under General Chemical's BAT Option 4 (Ref. 5), these streams would be further treated for TDS removal, and reused as raw water to plant processes (i.e. no effluent discharge).

Although zero-discharge of process contaminants to receiving waters would be achieved, technologies for removal of those contaminants that would be transferred to the environment in air emissions or solids waste would need to be considered. These contaminants include:

- Volatile organic compounds
- Trace extractable organics and dioxins and furans
- Phenolics
- Mercury.

**Volatile Organics:** Technologies for removal of volatile organic compounds recommended under BAT Option 1 are also recommended in BAT Option 4.

**Trace Extractable Organics and Dioxins:** Trace extractable organic compounds (at the ng/L level) and dioxin compounds (at the pg/L level) were detected in both Genetron™ process effluent streams. The sources of these compounds are not readily identifiable based on a review of the raw materials and processes. However, because most of these compounds were detected only in Genetron™ process effluents and not in other streams at Allied Chemicals or General Chemical, their formation within the Genetron™ process is probable. A detailed review by the plant is necessary to identify the mechanism for formation of these compounds, and if possible, control methods.

Treatment methods for reduction of these compounds in wastewater include GAC adsorption and TSS removal, because these compounds are often adsorbed on solids. Both of these technologies have already been recommended under BAT Option 4 for the control of volatile organic compounds.

**Phenolics:** Low levels (<43 µg/L) of total phenolics were present in both streams. In the Genetron™ sump effluents, a specific phenolic source was not identified. However, phenols could be associated with low levels of oil and grease in effluents. In the hydrochloric acid stream, phenolics sources were not identified in a review of materials used at the plant. However, phenolics are likely related to the process. In both cases, source control cannot be precisely defined.



Significant reduction of phenolics will take place in the GAC contactors and therefore, no other treatment is recommended.

**Mercury:** Sources of mercury were not identified in the Genetron™ sump stream. Mercury, was detected at low levels in nearly all wastewaters generated at Allied and General Chemical. Since it is not likely process related, mercury sources and control methods should be identified within a Storm Water Control Study. Technologies for reducing mercury in industrial wastewaters at concentrations less than 5 µg/L were not identified in a global search.

## Scenario 2

As described for BAT Option 1, TSS removal from the Genetron™ sump stream and carbon treatment of both streams would also be included in BAT Option 4 for volatile organic compound removal. Reduction of other contaminants detected in each of the effluent streams also needed to be considered under BAT Option 4. Contaminants detected in these streams include:

- Phenolics
- Trace extractable organics and dioxins and furans
- Metals
- Oil and grease
- Total dissolved solids.

Removal of phenolics and trace extractable organics and dioxin furan compounds in the GAC contactor, as discussed for Scenario 1, also applies to Scenario 2. In addition, mercury reduction in a Storm Water Control Study is also recommended.

**Metals:** Many metals, including aluminum, copper, boron and zinc were likely contributed to effluents primarily from the raw water source. In a thorough review of plant processes and raw materials, the primary sources of low levels of other metal contaminants, such as cadmium, chromium, strontium, arsenic and mercury were not identified. However, with the exception of mercury in the Genetron™ sump stream, all metal contaminants were present in both streams. This suggests that these metals are contributed in the process. A more detailed review of the process, raw materials quality and equipment materials is necessary to identify sources of these contaminants, so that source controls, if possible, can be developed.

Antimony, present in both process wastewaters likely originates from the antimony pentachloride catalyst used in the manufacture of certain Genetron™ products. A detailed understanding of the production process is necessary to establish whether alternate catalysts are available and would contribute less contamination to process effluents. This evaluation must be carried out by Allied Chemicals. Within the scope of this study, other methods for source control of antimony were not considered.

Some removal of metal components in the Genetron™ sump stream will be achieved through neutralization and settling of metal precipitates. In addition, some removal of metals from both streams will occur through adsorption on the GAC contactor, and through TSS removal as a result of the filtering action of GAC media. Demonstrated technologies for further removal of these contaminants from industrial wastewater were not identified in a global search. However, technologies for elimination of the hydrochloric acid stream from discharge (to be discussed) would also eliminate metal discharges from this stream.

**Oil and Grease:** Oil and grease levels in both effluent streams were low ( $< 3$  mg/L), and not significantly different from intake water quality. Absorbion technologies are available for further reducing oil and grease. However, because effluent loadings from the Genetron™ plant are very low (0.7 kg/d total), these technologies are not considered to be practical.

**Total Dissolved Solids:** Generally total inorganic contaminants in the Genetron™ sump effluents (PR0100), with the exception of fluoride (45 mg/L), were not excessive. For many months of the MISA monitoring period, mean fluoride levels less than 10 mg/L were achieved. High fluoride excursions were likely related to poor TSS removal and acidic pH values. TSS removal has already been recommended for this stream in Scenario 2. Lime addition for fluoride removal is the recommended technology for the hydrofluoric acid plant effluents (PR0300). Rather than implement a second lime treatment system in the Genetron™ plant, transfer of this stream (after GAC treatment) to the hydrofluoric acid plant wastewater treatment system is recommended.

Because the second Genetron™ process stream (PR0600) is a hydrochloric acid solution, dissolved solids (i.e. chloride) levels are high. Options identified for reducing dissolved solids discharged from this stream include:

- Neutralization and TDS removal in a brine concentrator, and disposal of solid waste residue.
- Eliminating the source of the stream by selling the hydrochloric acid solution.
- Implementation of a calcium chloride production process for chloride recovery.

The least cost solution is to identify a market and sell the carbon treated hydrochloric acid stream. Within the scope of this study, it cannot simply be assumed that a market exists, and therefore, this alternative was not considered further.

At one "sister" U.S. chlorofluorocarbon manufacturing facility, a calcium chloride production plant was implemented that uses the waste acid as a raw material (Ref. 3). The process involves reacting limestone with hydrochloric acid to create calcium chloride solution for sale.

Neutralization and concentration of salt residues is a third alternative available for addressing the high TDS concentration in the HCl stream. This technology would result in a high quality effluent stream available for reuse in the plant, and a solid residue requiring disposal.

Under BAT Option 4, implementation of a calcium chloride production process for recovering chloride from the hydrochloric acid stream is recommended. This process is more desirable from a cost standpoint, since it produces a saleable product, rather than a solid waste requiring disposal.

### **3.4.3      Summary**

For Scenario 1, the following technologies are recommended for maximum removal of contaminants under BAT Option 4.

- No change to existing hydrofluoric acid plant effluent treatment system (PR0300).
- Settling and GAC adsorption of Genetron™ process sump effluents (PR0100).
- GAC adsorption of the hydrochloric acid scrubber stream (PR0600).

In Scenario 2, if Allied were to discharge effluents directly from their site, and operate independently of General Chemical, BAT Option 4 would include the following technologies:

- Implementation of lime addition to the residue sump for treatment of hydrofluoric acid plant effluents (PR0300).
- Settling and GAC adsorption of Genetron™ process sump effluents, followed by mixing with the hydrofluoric acid plant effluents for lime treatment (PR0100).
- GAC adsorption of hydrochloric acid scrubber stream.
- Reuse of treated hydrochloric acid scrubber effluent in the production of calcium chloride (PR0600).

### **3.5      BAT Options 5**

BAT Option 5 includes those technologies that would move the facility furthest towards zero-discharge of wastewater pollutants.



## **Scenario 1**

Under the current operation where wastewater management at Allied Chemicals and General Chemical are interdependent, zero-discharge would be achieved according to the recommended BAT Option 5 for General Chemical (Ref. 5). In this option, TDS removal from soda ash settling basin effluents in a six effect evaporator would result in a high quality effluent stream available for reuse in the plant, and ultimate zero-discharge of process effluents. In addition, prior treatment of these effluent streams with activated carbon as described in BAT Option 4 will reduce the release of organic contaminants to the environment through cross media transfer.

## **Scenario 2**

In Scenario 2, where Allied would operate independently, the treated hydrofluoric acid plant effluents combined with the Genetron<sup>TM</sup> sump stream be the only discharge stream (according to BAT Option 4). A portion of this stream is currently recycled at the plant. However, raw water is still used to supplement this recycle water for scrubbing and gypsum slurring, indicating that a greater proportion of wastewater recycle is possible.

When lime treatment is used, equipment scaling has been shown to be a limiting factor in increasing recycle rates. During the development of U.S. effluent regulations in the 1970s, one plant had achieved complete recycle with the use of soda ash instead of lime (Ref. 4). The evaluation of lime treatment versus soda ash treatment with respect to scaling would need to be considered by Allied Chemicals. In addition, a detailed review of the wastewater management in terms of flow balancing must be evaluated to identify appropriate flow control methods to maximize recycle rates and possibly achieve zero-discharge. Maximizing recycle of hydrofluoric acid plant effluents is recommended under BAT Option 5.

It is noteworthy that dry handling of kiln residues in the manufacture of hydrofluoric acid has been used in the U.S. (Ref. 5) and is used at many European plants (Ref. 6). Dry handling involves mixing the kiln effluents with lime, and the dried solids may be landfilled. In Europe, this material has also been marketed as filler material in concrete structural panels. Dry handling is more labour intensive, and residual sulphur trioxide and hydrogen fluoride in the solids create safety, handling and storage concerns. For these reasons, and because there would not likely be a market for these wastes in Ontario because of the relatively inexpensive and available supply of construction materials, dry handling of kiln effluents is not recommended.

### **3.6 Summary of BAT Options**

Table 3 presents a summary of BAT Options recommended for Allied Chemicals Canada Ltd.

**Table 3**  
**Summary of BAT Options for Allied Chemicals Canada Ltd.**

BAT Option	Definition	Description	
		Scenario 1	Scenario 2
1	Least cost producing non-lethal effluents.	No option defined.	No option defined.
2	U.S. BAT.	<p>HF Effluent (PR0300)</p> <ul style="list-style-type: none"> <li>No change to existing system.</li> <li>(Soda ash settling basin at General Chemical)<sup>1</sup></li> </ul> <p>Genetron<sup>TM</sup> Sump (PR0100)</p> <ul style="list-style-type: none"> <li>Settling</li> <li>GAC contactor.</li> <li>(Soda ash settling basin at General Chemical)<sup>1</sup></li> </ul> <p>HCl Scrubber (PR0600)</p> <ul style="list-style-type: none"> <li>GAC contactor.</li> <li>(Calcium chloride process at General Chemical)<sup>1</sup></li> </ul>	<p>HF Effluent (PR0300)</p> <ul style="list-style-type: none"> <li>Lime precipitation of effluents in existing system.</li> </ul> <p>Genetron<sup>TM</sup> Sump (PR0100)</p> <ul style="list-style-type: none"> <li>Settling</li> <li>GAC contactor</li> <li>Combine with PR0600 for neutralization.</li> </ul> <p>HCl Scrubber (PR0600)</p> <ul style="list-style-type: none"> <li>GAC contactor</li> <li>Combine with PR0100 for neutralization.</li> </ul>
3	Best demonstrated in Ontario.	No change existing system.	No change to existing system.
4	Maximum reduction of contaminants.	<p>HF Effluent (PR0300)</p> <ul style="list-style-type: none"> <li>No change to existing system (assuming TDS removal at General Chemical)<sup>1</sup>.</li> </ul> <p>Genetron<sup>TM</sup> Sump (PR0700)</p> <ul style="list-style-type: none"> <li>Settling</li> <li>GAC contactor</li> <li>(assuming TDS removal at General Chemical)<sup>1</sup>.</li> </ul> <p>HCl Scrubber (PR0600)</p> <ul style="list-style-type: none"> <li>GAC contactor</li> <li>(Calcium chloride process at General Chemical)<sup>1</sup>.</li> </ul>	<p>HF Effluent (PR0300)</p> <ul style="list-style-type: none"> <li>Lime precipitation of effluents in existing system.</li> </ul> <p>Genetron<sup>TM</sup> Sump (PR0100)</p> <ul style="list-style-type: none"> <li>Settling</li> <li>GAC Contactor</li> <li>Mixing with HF wastewater treatment process.</li> </ul> <p>HCl Scrubber (PR0600)</p> <ul style="list-style-type: none"> <li>GAC contactor</li> <li>Eliminate HCl stream by implementing calcium chloride production facility.</li> </ul>
5	Furthest towards zero-discharge of pollutants.	Same as BAT Option 4, with maximum recycle of HF pond effluents.	Same as BAT Option 4, with maximum recycle of HF pond effluents.
Notes:			
1. Ref. 5.			

#### 4.0 BAT OPTIONS

BAT Option 1 was undefined, and no changes to the existing system were included in BAT Option 3. The following sections present projected performance and cost estimates for implementation of BAT Options 2, 4 and 5.

## **4.1            BAT Option 2**

Figure A1 in the Appendix presents a schematic of the technologies included for both Scenarios in BAT Option 2.

### **4.1.1            Hydrofluoric Acid Plant - Lime Treatment**

#### **Description**

In Scenario 2, brine muds from General Chemical would not be available for neutralization of effluents. The existing residue pit system would be used for lime treatment. The system would be required to treat approximately 14,000 m<sup>3</sup>/d of gypsum slurry water, mixed with approximately 1,000 m<sup>3</sup>/d of wastewater from other sources, including scrubber water, cooling tower blowdown, wash water and some storm water runoff (Ref. 2).

The lime system would include the following components:

- Lime storage silo
- Screw feeder
- Slurry tank
- Two slurry pumps
- pH probe and dosage controller

Lime requirements were calculated based on an untreated effluent fluoride concentration of 2,400 mg/L (Ref. 6), and assuming correct stoichiometric ratios to achieve a neutral effluent. This results in a lime demand of 0.9 t/d. Assuming greater than one month storage capacity in the lime silo, a storage volume of approximately 50 m<sup>3</sup> is required.

#### **Performance**

The reported effluent quality resulting from current treatment with brine muds, shown in Table A2, is predicted to be achievable with lime treatment.

#### **Costs**

Capital and operating costs estimated for the lime storage silo and feed system are presented in Table 4.

<p align="center"><b>Table 4</b>  <b>Estimated Costs for the Lime Storage Silo and Feed System for Treating Hydrofluoric Acid Plant Effluents</b></p>	
<b>Component</b>	<b>Cost</b>
<b>Capital costs<sup>1,2</sup></b> • Includes lime storage silo, feeder, slurry tank, flow meters, pump and control panel.	\$260,000
<b>Operating costs</b> • Lime (\$150/t)	\$50,000/y
Notes:  1. Includes 35 percent installation, 30 percent estimating contingency, 15 percent engineering and 7 percent G.S.T. 2. ENR CCI 6343.	

#### 4.1.2 Genetron™ Plant Sump Effluent (PR0100) Settling

##### Description

Sedimentation of solids in the Genetron™ sump effluent stream is required to reduce suspended solids levels to less than 50 mg/L, to avoid fouling of the GAC contactor downstream. For the purposes of costing, a steel circular above ground clarifier with scraper, drive and bottom rake (thickener) sized for typical overflow rates at the maximum flow rate observed over the 12 months monitoring period was assumed. Table 5 presents the design characteristics.

<p align="center"><b>Table 5</b>  <b>Design Characteristics of Clarifier for Genetron™ Sump Effluents</b></p>	
<b>Item</b>	<b>Value</b>
Diameter	3.8 m
Overflow rate at 549 m <sup>3</sup> /d (peak)	49 m <sup>3</sup> /m <sup>2</sup> /d
Overflow rate at 191 m <sup>3</sup> /d (average)	17 m <sup>3</sup> /m <sup>2</sup> /d
Weir loading rate at 549 m <sup>3</sup> /d (peak)	46 m <sup>3</sup> /m <sup>2</sup> /d
Weir loading rate at 191 m <sup>3</sup> /d (average)	16 m <sup>3</sup> /m <sup>2</sup> /d
Sludge generation (assuming 5% solids)	0.9 m <sup>3</sup> /d



## Performance

Sedimentation of solids is projected to achieve an average TSS concentration of 20 mg/L. Actual performance will depend on settleability of solids, and should be determined using jar tests.

## Costs

The estimated capital and operating costs for implementing a clarifier to treat Genetron™ process effluents (PR0100) are presented in Table 6.

Table 6 Estimated Costs for Implementation of Clarifier for Treatment of Genetron™ Sump Effluents <sup>1</sup>	
Item	Cost
Capital cost, includes steel clarifier, above ground, 3.8 m diameter, scraper and drive.	\$210,000 <sup>2,3</sup>
Operating costs <ul style="list-style-type: none"><li>• Energy, maintenance</li><li>• Sludge disposal (@ \$350/m<sup>3</sup>)</li></ul>	<div>\$4,000/y</div> <div>\$115,000/y</div> <div>\$119,000/y</div>
Notes:  1. Ref. 7. 2. Includes 15 percent engineering, 35 percent installation, 30 percent contingency allowance and 7 percent G.S.T. 3. ENR CCI 6343.	

### **4.1.3      Genetron™ Effluents (PR0100 and PR0300) - GAC Adsorption**

#### Description

In BAT Option 2, GAC adsorption was recommended for treatment of each individual process streams (PR0100 and PR0600) for removal of volatile organic compounds.

Separate carbon treatment systems are required for two reasons:

- Each process wastewater is managed differently in the current system.

- Mixing of the acid and neutral stream before carbon treatment would likely result in the evolution of gases and vapour, that would also contain volatile organics. An additional air collection and treatment step would be required to prevent releases of volatile organics to air.

Despite the relatively small flow rates of both streams, large carbon contactor systems are required based on the adsorption capacity of carbon and the adsorptive nature of many of the volatile compounds present in the system.

The contactors were approximately sized for the purpose of costing based on the weight of carbon needed to adsorb one of the least adsorbent molecules present at high concentrations. Chloroform was selected, since it contributed the highest individual contaminant loading in the Genetron™ sump process stream. An arbitrary regeneration frequency of 14 days was also assumed. Less frequent regeneration rates would increase the carbon bed size, while more frequent rates would increase operating costs.

The theoretical adsorption isotherms represented by the Freundlich adsorption equation were used to calculate carbon requirements. The design features of the GAC contactor systems for each of the two Genetron™ process streams are presented in Table 7.

Table 7 Design Features of GAC Contactor Systems for Genetron™ Process Effluents		
Component	Genetron™ Sump PR0100	HCl Scrubber PR0600
GAC weight	2,100 kg	3,800 kg
Number of contactors	2 @ 2,100 kg GAC	2 @ 3,800 kg GAC
Regeneration frequency (per contactor)	1/month	1/month

Two options are usually available for regenerating exhausted carbon. In the first option, the carbon supplier would pick-up GAC media and replace with regenerated media as required. This option would not be available to Allied Chemicals, because regeneration of GAC containing dioxin compounds is not carried out in Ontario (Ref. 9). These compounds are present in both effluent streams and would be readily adsorbed to GAC media; therefore, either disposal or onsite GAC regeneration is required. For the purposes of costing, an onsite system was considered.

Regeneration of activated carbon involves washing GAC and air scouring, feeding GAC into a furnace, water quenching GAC from the furnace and hydraulically transporting media back to carbon unit. Virgin GAC is added to replace attrition losses.



A variety of furnace designs have been used. For the purposes of this study, a multiple hearth furnace was assumed. To meet air emission requirements, particularly when associated with the presence of dioxins, a tailgas afterburner is required. It is important to note that obtaining approval for the facility where dioxins are present in the wastes may be a long term and costly undertaking.

## **Performance**

Performance efficiencies for the GAC filter media were theoretically determined using the Freundlich adsorption equation and the empirical constants presented in Ref. 8. In reality, the presence of competing organics will limit the removal performance, and will shorten the effective life span of the media. The actual performance and the effective life time that can be achieved will vary depending on the wastewater characteristics and can only be determined through testing.

The projected performance resulting from the implementation of the GAC filter on the two Genetron™ streams is presented in Table 8. Some removal of metals will also be achieved in the GAC contactors, although theoretical isotherm data were unavailable for calculation of removal efficiencies.

## **Costs**

Capital and operating costs were estimated for implementation of the GAC contactor systems for each process stream, in addition to a carbon regeneration facility. These costs are presented in Table 9.

### **4.1.4      Neutralization of Combined Genetron™ Process Effluent Streams (PR0100 and PR0600)**

#### **Description**

In Scenario 2 only, neutralization of the HCl stream was also recommended in BAT Option 2 prior to direct discharge from Allied Chemicals. As shown in Figure A1, this would be accomplished by mixing the two Genetron™ effluent streams, and addition of a caustic slurry to further adjust the pH.

The neutralization system consists of a rapid mix tank. The pH in the tank is monitored continuously and controls the rate of caustic slurry feed into the pipe upstream of the tank. The combined neutralized effluent would be discharged directly.

**Table 8**  
**Projected Performance of GAC Adsorption on Genetron™ Effluent Streams**

Parameter	Genetron Sump (PR0100)			HCl Scrubber (PR0600)		
	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction <sup>4</sup>
Bromomethane • (kg/d) • (µg/L)	0.201 1,400	n.d. n.d.	n.d.	1.548 38,800	n.d. n.d.	n.d.
Bromoform • (kg/d) • (µg/L)	0.016 114	<0.000 0.11	>99.9%	0.121 2,740	<0.0001 <2	>99.9%
Dibromochloromethane • (kg/d) • (µg/L)	0.019 136	0.002 1.3	98.7%	0.141 3,010	0.0018 29	98.7%
Chloromethane • (kg/d) • (µg/L)	0.027 192	n.d. n.d.	n.d.	0.191 3,680	n.d. n.d.	n.d.
Chloroform • (kg/d) • (µg/L)	0.792 4,610	0.080 420	90%	0.991 15,500	0.099 1,584	90%
Carbon tetrachloride • (kg/d) • (µg/L)	0.106 736	0.002 8	98.6%	0.192 3,130	0.0027 43	98.6%
Methylene chloride • (kg/d) • (µg/L)	0.058 389	0.067 352	0%	1.192 18,500	1.192 18,500	0%
Trichlorofluoromethane • (kg/d) • (µg/L)	0.219 1,240	0.007 3.7	99.7%	5.512 88,700	0.017 272	99.7%
Tetrachloroethylene • (kg/d) • (µg/L)	0.019 136	<0.0000 0.02	>99.9%	0.141 3,010	<0.0001 <2	>99.9%
Trichloroethylene • (kg/d) • (µg/L)	0.034 235	<0.0000 0.12	>99.9%	0.256 6,250	<0.0003 <5	>99.9%
trans-1,2-Dichloroethylene • (kg/d) • (µg/L)	0.016 114	0.0004 2	98%	0.121 2,740	0.0024 38	98%
Vinyl chloride • (kg/d) • (µg/L)	0.027 192	n.d. n.d.	n.d.	0.191 3,680	n.d. n.d.	n.d.
1,1-Dichloroethane • (kg/d) • (µg/L)	0.013 92	0.0006 3.3	95%	0.101 2,470	0.0051 82	95%
1,1-Dichloroethylene • (kg/d) • (µg/L)	0.016 114	0.0002 0.84	99%	0.121 2,740	0.0012 19	99%

**Table 8**  
**Projected Performance of GAC Adsorption on Genetron™ Effluent Streams**

Parameter	Genetron Sump (PR0100)			HCl Scrubber (PR0600)		
	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction <sup>4</sup>
1,1,2-Trichloroethane • (kg/d) • (µg/d)	0.018 125	0.0002 1.2	98.7%	0.131 2,880	0.0017 27	98.7%
1,1,2,2-Tetrachloroethane • (kg/d) • (µg/d)	0.019 129	<0.0000 0.006	>99.9%	0.184 4,230	<0.0002 <3	>99.9%
1,2-Dichloroethane • (kg/d) • (µg/d)	0.015 103	0.003 13	83%	0.111 2,610	0.019 304	83%
1,2-Dichloropropane • (kg/d) • (µg/d)	0.013 92	0.0002 0.88	99%	0.101 2,470	0.001 16	99%
cis-1,3-Dichloropropylene • (kg/d) • (µg/d)	0.067 477	0.0005 2.6	99.3%	0.523 12,600	0.0037 59	99.3%
trans-1,3-Dichloropropylene • (kg/d) • (µg/d)	0.016 114	<0.0000 0.14	99.8%	0.121 2,740	0.0002 4	99.8%
Chlorobenzene • (kg/d) • (µg/d)	0.015 103	0.0002 1.0	98.7%	0.111 2,610	0.0014 22	98.7%
Ethylene dibromide • (kg/d) • (µg/d)	0.015 103	n.d. n.d.	n.d.	0.111 2,610	n.d. n.d.	n.d.
1,2-Dichlorobenzene • (kg/d) • (µg/d)	0.035 246	<0.0000 0.0004	>99.9%	0.266 6,390	<0.0003 <5	>99.9%
1,3-Dichlorobenzene • (kg/d) • (µg/d)	0.041 286	<0.0000 0.0001	>99.9%	0.312 7,560	<0.0003 <5	<99.9%
1,4-Dichlorobenzene • (kg/d) • (µg/d)	0.061 425	$10 \times 10^{-8}$ 0.005	>99.9%	0.473 12,000	<0.0005 <8	<99.9%
Benzene • (kg/d) • (µg/d)	0.013 92	0.013 92	0%	0.101 2,470	0.101 2,470	0%
m&p-xylene • (kg/d) • (µg/d)	0.015 103	<0.0000 <0.000	>99.9%	0.111 2,610	<0.0001 <2	<99.9%
o-xylene • (kg/d) • (µg/d)	0.019 136	<0.0000 <0.000	>99.9%	0.141 3,010	<0.0001 <2	<99.9%

**Table 8**  
**Projected Performance of GAC Adsorption on Genetron™ Effluent Streams**

Parameter	Genetron Sump (PR0100)			HCI Scrubber (PR0600)		
	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction <sup>4</sup>
Toluene • (kg/d) • (µg/L)	0.016 102	<0.0000 0.004	>99.9%	0.144 2,360	<0.0001 <2	>99.9%
Styrene • (kg/d) • (µg/L)	0.038 268	<0.0000 <0.000	>99.9%	0.287 6,660	<0.0003 <5	>99.9%
Acrolein • (kg/d) • (µg/L)	0.139 1,110	0.0128 672	92.3%	1.168 29,200	0.09 1,439	92.3%
Acrylonitrile • (kg/d) • (µg/L)	0.072 577	0.0235 123	32.6%	0.617 15,000	0.416 6,656	32.6%
Bis(2-ethylhexylphthalate) • (kg/d) • (µg/L)	0.003 15.9	<0.0000 0.15	99.0%	0.0009 14.1	<0.0000 0.141	99.0%
Hexachlorobutadiene • (g/d) • (ng/L)	0.039 205	<0.0000 <0.000	>99.9%	0.326 5,220	<0.0003 <5	>99.9%
Hexachloropentadiene • (g/d) • (ng/L)	0.062 325	<0.0000 <0.000	>99.9%	0.332 5,320	<0.0003 <5	>99.9%
Hexachlorobenzene • (g/d) • (ng/L)	0.388 2,030	<0.0000 0.002	>99.9%	0.065 1,040	<0.0001 <1	>99.9%
Hexachloroethane • (g/d) • (ng/L)	0.208 1,090	<0.0000 <0.000	>99.9%	1.15 18,400	<0.001 <20	>99.9%
Octachlorostyrene • (g/d) • (ng/L)	0.018 93	<0.0000 <0.000	>99.9%	0.065 1,040	<0.00007 <1	>99.9%
Pentachlorobenzene • (g/d) • (ng/L)	0.035 183	<0.0000 <0.000	>99.9% <sup>3</sup>	0.326 5,210	<0.0003 <5	>99.9%
2,4,5-Trichlorotoluene • (g/d) • (ng/L)	0.087 455	<0.0000 <0.000	>99.9% <sup>3</sup>	0.844 13,500	<0.0008 <14	>99.9%
1,2,3-Trichlorobenzene • (g/d) • (ng/L)	0.070 368	<0.0000 <0.000	>99.9% <sup>3</sup>	1.15 18,400	<0.0001 <2	>99.9%
1,2,3,4-Tetrachlorobenzene • (g/d) • (ng/L)	0.042 219	<0.0000 <0.000	>99.9% <sup>3</sup>	0.326 5,210	<0.0003 <5	>99.9%



**Table 8**  
**Projected Performance of GAC Adsorption on Genetron™ Effluent Streams**

Parameter	Genetron Sump (PR0100)			HCl Scrubber (PR0600)		
	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction	Influent Quality <sup>1</sup>	Effluent Quality <sup>2</sup>	Loading Reduction <sup>4</sup>
1,2,3,5-Tetrachlorobenzene • (g/d) • (ng/L)	0.035 185	<0.0000 <0.000	>99.9% <sup>3</sup>	0.326 5,210	<0.0003 <5	>99.9%
1,2,4-Trichlorobenzene • (g/d) • (ng/L)	0.206 1,080	<0.0000 <0.000	>99.9% <sup>3</sup>	0.681 10,900	>0.0007 <12	>99.9%
1,2,4,5-Tetrachlorobenzene • (mg/d) • (ng/L)	0.035 185	<0.0000 <0.000	>99.9% <sup>3</sup>	0.326 5,210	<0.0003 <5	>99.9%
Total H7CDD • (mg/d) • (pg/L)	0.006 30	<0.0000 <0.000	>99.9% <sup>3</sup>	n.p. <sup>6</sup>	n.p.	n.p.
Total H7CDF • (mg/d) • (pg/L)	0.015 80	<0.0000 <0.000	>99.9% <sup>3</sup>	n.p. <sup>6</sup>	n.p.	n.p.
Octachloribenzodioxin • (mg/d) • (pg/L)	0.038 197	<0.0000 <0.000	>99.9% <sup>3</sup>	0.0083 133	<0.00008 <1	>99.9%
Octachloridibenzofuran • (mg/d) • (pg/L)	0.340 1,780	<0.0000 <0.000	>99.9% <sup>3</sup>	n.p. <sup>6</sup>	n.p.	n.p.
Phenolics • (g/d) • (µg/L)	1.1 6	0.0002 1	>99.9%	8.2 43	0.002 10	>99.9%
Notes: 1. Based on 12-month mean data from MISA Control Points PR0100 and PR0600. 2. Theoretical effluent concentration. Loading based on mean 12-month low rate and theoretical concentrations. 3. Assumed based on known high adsorption potential of compound. 4. Assumed equal to theoretical percentage reductions at PR0700. 5. Based on removal of a least adsorbent phenolic compound, 4-nitrophenol, as a worst-case scenario. 6. Not a "Priority 1" pollutant.						

### Performance

The combined process effluent discharge would have a pH of 6.5 to 8.5.



<p align="center"><b>Table 9</b> <b>Estimated Costs for GAC Contactor System</b></p>	
<b>Component</b>	<b>Cost</b>
<b>Capital Cost<sup>1,2</sup></b>	
• GAC Contactors	\$1,950,000
• Regeneration facility including tail gas after burner	1,200,000
<b>Total</b>	<b>\$3,150,000</b>
<b>Operating Costs</b>	
• Carbon	\$300,000
• Energy and steam	150,000
• Labour, maintenance	150,000
<b>Total</b>	<b>\$600,000</b>
<b>Notes:</b>  1. Estimates include 35 percent installation, 15 percent engineering, 30 percent estimating contingency, and seven percent G.S.T. Costs not included for approvals application process. 2. ENR CCI 6343.	

### Costs

Capital costs of the neutralization system, presented in Table 10, are estimated to total \$160,000 (ENR CCI 6343). The main operating cost component will be the neutralizing chemicals. The quantity of chemicals cannot be calculated because the buffering capacity of the process sump stream is unknown.

<p align="center"><b>Table 10</b> <b>Estimated Capital Cost of Neutralization System for Combined Genetron™ Wastewater</b></p>	
<b>Component</b>	<b>Cost<sup>1,2</sup></b>
Chemical storage tank, mix tank and feed systems	\$50,000
Continuous mix reactor	\$50,000
Instrumentation and controls	\$60,000
<b>Total</b>	<b>\$160,000</b>
<b>Notes:</b>  1. Includes 35 percent installation, 30 percent estimating contingency, 15 percent engineering and 7 percent G.S.T. 2. ENR CCI 6343.	

#### 4.1.5

#### Summary of BAT Option 2

Table 11 presents a summary of the estimated costs and projected performance of BAT Option 2.

Table 11 Estimated Costs and Projected Performance of BAT Option 2			
Technology	Costs	Parameter	Performance
Scenario 1			
Sedimentation of Genetron™ sump stream (PR0100)	\$210,000 capital \$119,000/y operating	TSS	20 mg/L
GAC adsorption of Genetron™ sump stream (PR0100) and HCl effluent (PR0600)	\$3,150,000 capital \$600,000/y operating	Volatile organic compounds	0 - >99.9% removal
		Extractable organic compounds	>99.9% removal
		Dioxin and furan compounds	>99.9% removal
		Phenolics	>99.9% removal
Scenario 2			
As above with:			
Neutralization of combined Genetron effluent stream (PR0100 & PR0600)	\$160,000 capital undefined operating	pH	6.5 to 8.5
Lime treatment of hydrofluoric acid plant effluent stream (PR0300)	\$260,000 capital \$50,000/y operating	All pollutants	no change from reported quality at PR0300 (Table A2)
Total for Scenario 1	\$3,360,000 capital \$719,000/y operating		
Total for Scenario 2	\$3,780,000 capital >\$769,000/y operating		

#### 4.2

#### BAT Option 4

A schematic of those technologies recommended under BAT Option 4 is presented in Figure A2. For Scenario 1, no technologies beyond those recommended for BAT Option 2 were included.

For Scenario 2, GAC treatment is recommended for both Genetron™ effluents, as described under BAT Option 2. The carbon treated Genetron sump effluent (PR0100) would then be transferred to the residue pit for lime treatment with hydrofluoric acid

wastewaters, as described for BAT Option 2. The carbon treated hydrochloric acid stream is sent to a new calcium chloride plant to recover the chloride as calcium chloride.

#### **4.2.1      Genetron™ Plant Sump Effluent (PR0100) - Lime Treatment**

##### **Description**

Process components required to transfer the Genetron™ sump effluent to the residue pit after GAC treatment are minimal. Major modifications include rerouting of the existing pipeline that currently transfers this effluent to General Chemical.

It is unlikely that any expansion to the residue pit would be required because 490 m<sup>3</sup>/d of brine muds are currently pumped to the residue pit for neutralization which would be eliminated, while only 191 m<sup>3</sup>/d would be added from the Genetron™ sump effluent with an estimated 9 m<sup>3</sup>/d required for lime slurry. Consequently the effluent discharge rate measured at Control Point PR0300 would not increase.

##### **Performance**

The flows through MISA Control Point PR0300 would not increase Scenario 2, even if the Genetron™ sump stream were added to the treatment system. Furthermore, effluent contaminant concentrations achievable in the lime treatment system would not change with the addition of the less contaminated PR0100 stream. Therefore, the ultimate effect would be equivalent to eliminating the discharge of the Genetron™ sump stream (PR0100).

##### **Costs**

Costs for rerouting the existing piping to transfer the Genetron™ process stream to the residue pit are estimated to be minimal. Significant increases in operating costs are not projected.

#### **4.2.2      Genetron™ Plant Hydrochloric Acid Effluent Stream (PR0600) - Calcium Chloride Recovery Facility**

##### **Description**

Installation of a calcium chloride production plant to process approximately 62 m<sup>3</sup>/d of spent hydrochloric acid scrubber water effluents is recommended.

According to a similar facility at a U.S. "sister" plant, the main components of the process include a bucket elevator to lift limestone to the top of fixed bed reactors. Gases exhausted from the reactors are water scrubbed in a venturi scrubber. The calcium chloride solution is clarified in rotary rake clarifier before being stored in tanks awaiting shipment. Extrapolated from the "sister" plant size, approximately 0.2 hectares are required for the plant and limestone storage (Ref. 3).

### **Performance**

Implementation of the calcium chloride plant will result in the elimination of the hydrochloric acid effluent discharge stream (PR0600). A venturi water scrubber will produce effluent at an estimated volume of 75 m<sup>3</sup>/d. It is feasible that this stream would not need to be discharged, but will be recycled from the hydrofluoric acid clear water pond system.

### **Costs**

A capital cost of \$6.5 million dollars is estimated for implementation of a calcium chloride plant on the Allied Chemicals site. Operating costs were not available (Ref. 3).

## **4.2.3      Summary of BAT Option 4**

Table 12 summarizes BAT Option 4 costs and technologies.

## **4.3      BAT Option 5**

### **Description**

BAT Options 4 & 5 cover those technologies that move the plant further towards zero-discharge of process contaminants. In Scenario 1, no additional technologies beyond these defined in BAT Option 4 were recommended because zero-discharge would be achieved under BAT Option 5 for General Chemical (Ref. 5).

In Scenario 2, according to BAT Option 4, only one stream would be discharged, that is, the overflow from the hydrofluoric acid plant effluent settling pond. If the recycle from this pond were to be increased, then less wastewater would be discharged. BAT Option 5 includes maximum recycle of pond water to minimize discharges, with the ultimate goal of achieving zero-discharge. The tasks which need to be undertaken to achieve maximum recycle are:

- Examination of the existing water management at the plant, to determine equalization, storage and operating requirements to maintain a water balance.



- Review of operating problems to determine if scaling is a factor when lime treatment is used. Alternate neutralization chemicals (e.g. soda ash) may be required.

**Table 12**  
**Estimated Costs and Projected Performance of BAT Option 4**

Technology	Costs	Parameter	Performance
<b>Scenario 1</b>			
Same as BAT Option 2 (Table 11)			
<b>Scenario 2</b>			
Sedimentation of Genetron™ sump stream (PR0100)	\$210,000 capital \$119,000/y operating	TSS	20 mg/L
GAC Adsorption of Genetron™ sump stream (PR0100) and HCl effluent (PR0600)	\$3,360,000 capital \$719,000/y operating	Volatile organic compounds. Extractable organic compounds Dioxin and furan compounds	0 to >99.9% removal >99.9% removal >99.9% removal
Calcium chloride plant for eliminating HCl effluent discharge (PR0600)	\$6,500,000 capital Undefined operating	All pollutants	Zero-discharge of contaminants through elimination of stream
Lime treatment of hydrofluoric acid plant effluent stream (PR0300) combined with PR0100 (after GAC treatment)	\$260,000 capital \$50,000/y operating	All pollutants (PR0300)  All pollutants (PR0100)	No change from reported quality (Table A2)  Zero-discharge of contaminants through elimination of stream
<b>Totals</b>	<b>Scenario 1</b> • \$3,360,000 capital • \$719,000/y operating  <b>Scenario 2</b> • \$10,300,000 capital • \$888,000/y operating		
<b>Notes:</b>  1. Includes 35 percent installation, 30 percent estimating contingency, 15 percent engineering and 7 percent G.S.T. 2. ENR CCI 6343.			

## Performance

The maximum recycle rate that can be achieved cannot be established until after the water balance has been prepared, and operating requirements identified.



## Costs

Costs of preparing the water balance and identifying operating requirements to maximizing recycle rates are projected to be small. Costs for implementing capital or operating changes to achieve maximum recycle cannot be established until operating requirements have been identified.

### 5.0 SUMMARY OF BAT OPTIONS

Table 13 summarizes cost and performance of BAT options recommended for Allied Chemicals Canada Ltd. BAT Option 1 was not identified, and therefore, results are not included in the Table.

Table 13 Summary of Costs and Performance of BAT Options				
	BAT Option 2	BAT Option 3	BAT Option 4	BAT Option 5
<b>Costs</b>				
Scenario 1				
• Capital	\$3,360,000	\$0	\$3,360,000	\$3,360,000
• Operating	\$719,000/y	\$0/y	\$719,000/y	\$719,000/y
Scenario 2				
• Capital	\$3,780,000	\$0	\$10,330,000	>\$10,330,000
• Operating	\$769,000/y	\$0/y	\$888,000/y	>\$888,000/y
<b>Contaminant Loading Reduction<sup>1</sup></b>				
Flow (m <sup>3</sup> /d) <sup>2</sup>	0	0	254	>254
TSS (kg/d)	>40	0	49	>49
Aluminum (kg/d) <sup>2</sup>	>0	0	0.431	>0.431
Boron (kg/d) <sup>2</sup>	>0	0	0.760	>0.760
Cadmium (kg/d) <sup>2</sup>	>0	0	0.002	>0.002
Chromium (kg/d) <sup>2</sup>	>0	0	0.009	>0.009
Copper (kg/d) <sup>2</sup>	>0	0	0.008	>0.003
Strontium (kg/d) <sup>2</sup>	>0	0	0.112	>0.112
Zinc (kg/d) <sup>2</sup>	>0	0	0.012	>0.012
Arsenic (kg/d) <sup>2</sup>	>0	0	0.041	>0.041
Antimony (kg/d) <sup>2</sup>	>0	0	0.048	>0.048
Mercury (kg/d) <sup>2</sup>	>0	0	0.00006	>0.00006
pH <sup>2</sup>	6.5-8.5	-	6.5-8.5	6.5-8.5

**Table 13**  
**Summary of Costs and Performance of BAT Options**

	BAT Option 2	BAT Option 3	BAT Option 4	BAT Option 5
<b>Volatile Organic Compounds (kg/d)</b>				
Bromomethane	>0	0	<0	>0
Bromoform	0.137	0	0.137	0.137
Dibromochloromethane	0.164	0	0.164	0.164
Chloromethane	>0	0	>0	>0
Chloroform	1.09	0	1.09	1.09
Carbon Tetrachloride	0.293	0	0.293	0.293
Methylene Chloride	0	0	0	0
Trichlorofluoromethane	5.7	0	5.7	5.7
Tetrachloroethylene	0.16	0	0.16	0.16
Trichloroethylene	0.29	0	0.29	0.29
trans-1,2-Dichloroethylene	0.134	0	0.134	0
Vinyl Chloride	>0	0	>0	>0
<b>Volatile Organic Compounds (kg/d) (Cont'd)</b>				
1,1-Dichloroethane	0.108	0	0.108	0.108
1,1-Dichloroethylene	0.136	0	0.136	0.136
1,1,2-Trichloroethane	0.147	0	0.147	0.147
1,1,2-Tetrachloroethane	0.203	0	0.203	0.203
1,2-Dichloroethane	0.104	0	0.104	0.104
1,2-Dichloropropane	0.113	0	0.113	0.113
cis-1,3-Dichloropropylene	0.586	0	0.586	0.586
Trans-1,3-Dichloropropylene	0.137	0	0.137	0
Chlorobenzene	0.124	0	0.124	0
Ethylene dibromide	>0	0	>0	>0
1,2-Dichlorobenzene	0.301	0	0.301	0.353
1,3-Dichlorobenzene	0.353	0	0.353	0.353
1,4-Dichlorobenzene	0.534	0	0.534	0.534
Benzene	0	0	0	0
m&p Xylene	0.126	0	0.126	0.126
o-Xylene	0.160	0	0.160	0.160
Toluene	0.160	0	0.160	0.160
Styrene	0.325	0	0.325	-

**Table 13**  
**Summary of Costs and Performance of BAT Options**

	BAT Option 2	BAT Option 3	BAT Option 4	BAT Option 5
Acrolein	1.20	0	1.20	1.20
Acrylonitrile	0.249	0	0.249	0.249
<b>Extractable Organics (g/d)</b>				
cis-(2-Ethylhexyl) phthalate	0.0039		0.0039	0.0039
Hexachloropentadiene	0.394	0	0.394	0.394
Hexachlorobutadiene	0.365	0	0.365	0.365
Hexachlorobenzene	0.453	0	0.453	0.453
Hexachloroethane	1.36	0	1.36	1.36
Octachlorostyrene	0.083	0	0.083	0.083
Pentachlorobenzene	0.361	0	0.361	0.361
2,4,5-Dinitrotoluene	0.931	0	0.931	0.931
1,2,3-Trichlorobenzene	1.22	0	1.22	0.122
1,2,3,4-Tetrachlorobenzene	0.368	0	0.368	0.368
<b>Extractable Organics (g/d) (Cont'd)</b>				
1,2,3,5-Tetrachlorobenzene	0.361	0	0.361	0.361
1,2,4-Trichlorobenzene	0.887	0	0.887	0.887
1,2,4,5-Tetrachlorobenzene	0.361	0	0.361	0.361
<b>Dioxin and Furan Compounds (mg/d)</b>				
Total H7CDD	0.006	0	0.006	0.006
Total H7CDF	0.015	0	0.15	0.015
Octachlorodibenzodioxin	0.039	0	0.039	0.039
Octachlorodibenzofuran	0.340	0	0.340	0.340
Phenolics (g/d)	9.3	0	0.3	9.3
Notes:				
1. Estimates for total plant loading reduction from combined monitored streams (PR0100, PR0200 and PR0300).				
2. Loading reduction only applicable in Scenario 2.				

## 6.0

## REFERENCES

1. Inorganic Chemical Sector Site Visit Report - General Chemical Canada Ltd. April 18, 1991 (unpublished).

2. Inorganic Chemical Sector Site Visit Report - Allied Chemicals Canada Ltd. April 15, 1991 (unpublished).
3. Inorganic Chemical Sector Global Study Site Visit Information Report - Allied Signal Inc. Baton Rouge South Works.
4. Development Document for Effluent Limitations Guidelines and Standard for the Inorganic Chemicals Manufacturing Point Source Category. U.S. EPA Report EPA 440/1-79/007, June 1980.
5. Ontario Inorganic Chemical Sector Plant Report on BAT Options - General Chemical Canada Ltd.
6. Inorganic Chemical Sector Global Study Site Visit Information Report - Allied Signal Industrial Chemical Division, Geismar.
7. General Technology Report - Sedimentation for TSS Removal.
8. J.N. Patterson. *Industrial Wastewater Treatment Technology* Second Edition. Butterworth-Heinmann. 1985.
9. Telephone conversation with Paul Boron of Calgon, October 1991.





## **APPENDIX**

### **Tables and Figures**



**Table A1, Allied Chemicals Canada Inc.****Summary of Flows and Priority One Pollutants****MISA Control Point: PR0100****Description: Genetron Sump**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	6	549	191	
Hydrogen Ion (pH)		1.2	12.8	8.7	
Total Kjeldahl Nitrogen	mg/L	0.06	1.1	0.518	0.084
Nitrate and Nitrite	mg/L	0.36	1.76	0.881	0.167
DOC	mg/L	0.1	339	14.5	1.794
TOC	mg/L	0.9	342	22	2.849
Specific Conductance	uS/cm	244	132000	3450	
Total Suspended Solids	mg/L	1	77000	224	48.862
Aluminum	ug/L	10	2150	485	0.102
Boron	ug/L	5	5030	1810	0.431
Cadmium	ug/L	1	56	10	0.002
Chromium	ug/L	20	70	29	0.006
Copper	ug/L	10	60	15	0.003
Strontium	ug/L	1	100	7	0.1
Zinc	ug/L	10	1070	71	0.011
Arsenic	ug/L	2	7910	203	0.036
Antimony	ug/L	1	5940	249	0.043
Mercury	ug/L	0.1	5.2	0.296	0.00006
Phenolics (4AAP)	ug/L	1	35	6	0.001
Bromomethane	ug/L	43	6720	1400	0.201
Bromoform	ug/L	8.6	420	114	0.016
Dibromochloromethane	ug/L	8.6	420	136	0.019
Chloromethane	ug/L	8.6	430	192	0.027
Chloroform	ug/L	59	120000	4610	0.792
Carbon Tetrachloride	ug/L	20	3440	736	0.106
Methylene Chloride	ug/L	8.6	13000	389	0.058
Trichlorofluoromethane	ug/L	20	16000	1240	0.219
Tetrachloroethylene	ug/L	8.6	420	136	0.019
Trichloroethylene	ug/L	13	1050	235	0.034
Trans-1,2-Dichloroethylene	ug/L	8.6	420	114	0.016
Vinyl Chloride	ug/L	8.6	430	192	0.027
1,1-Dichloroethane	ug/L	4	420	92	0.013
1,1-Dichloroethylene	ug/L	8.6	420	114	0.016
1,1,2-Trichloroethane	ug/L	8.6	420	125	0.018
1,1,2,2-Tetrachloroethane	ug/L	6.3	630	129	0.019
1,2-Dichloroethane	ug/L	8.6	420	103	0.015
1,2-Dichloropropane	ug/L	4	420	92	0.013
cis-1,3-Dichloropropylene	ug/L	8.6	2100	477	0.067
Trans-1,3-Dichloropropylene	ug/L	8.6	420	114	0.016
Chlorobenzene	ug/L	8.6	420	103	0.015

For validated data  
see final table

**Table A1, Allied Chemicals Canada Inc.**

Summary of Flows and Priority One Pollutants

MISA Control Point: PR0100

Description: Genetron Sump

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Ethylene Dibromide	ug/L	8.6	420	103	0.015
1,2-Dichlorobenzene	ug/L	17	1050	246	0.035
1,3-Dichlorobenzene	ug/L	17	1260	286	0.041
1,4-Dichlorobenzene	ug/L	9	2100	425	0.061
Benzene	ug/L	4	420	92	0.013
m & p-xylene	ug/L	8.6	420	103	0.015
o-xylene	ug/L	8.6	420	136	0.019
Toluene	ug/L	2.8	2580	102	0.016
Styrene	ug/L	21.5	1050	268	0.038
Acrolein	ug/L	215	2100	1118	0.139
Acrylonitrile	ug/L	108	1050	577	0.072
Bis(2-Ethylhexyl)Phthalate	ug/L	1.5	45	9.9	0.003
Hexachlorobutadiene	ng/L	5	100	205	0.00004
Hexachlorocyclopentadiene	ng/L	5	1000	325	0.00006
Hexachlorobenzene	ng/L	1	16000	2030	0.00039
Hexachloroethane	ng/L	5	3300	1090	0.00021
Octachlorostyrene	ng/L	1	517	93	0.00002
Pentachlorobenzene	ng/L	5	500	183	0.00003
2,4,5-Trichlorotoluene	ng/L	10	1000	455	0.00009
1,2,3-Trichlorobenzene	ng/L	10	1000	368	0.00007
1,2,3,4-Tetrachlorobenzene	ng/L	5	500	219	0.00004
1,2,3,5-Tetrachlorobenzene	ng/L	5	500	185	0.00004
1,2,4-Trichlorobenzene	ng/L	10	4200	1080	0.00021
1,2,4,5-Tetrachlorobenzene	ng/L	5	500	185	0.00004
Total H7CDD	pg/L	10	86	30	0.00000
Total H7CDF	pg/L	4	410	80	0.00000
Octachlorodibenzo-p-dioxin	pg/L	20	490	197	0.00000
Octachlorodibenzofuran	pg/L	20	9800	1780	0.00000
Oil and Grease	mg/L	1	16	2.9	0.629
Chloride, Unfiltered Reactive	mg/L	77	1300	488	88.931
Fluoride, Unfiltered Reactive	mg/L	0.62	908	45	5.982
Sulphate, Unfiltered Reactive	mg/L	30	75	55	8.937

**Table A2, Allied Chemicals Canada Inc.****Summary of Flows and Priority One Pollutants****MISA Control Point: PR0300****Description: HF Bleed**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	578	7530	6210	
COD	mg/L	10	60	36.25	235.754
Total Kjeldahl Nitrogen	mg/L	0.6	1.22	0.765	4.989
DOC	mg/L	0.1	39.9	3.1	19.4
TOC	mg/L	0.8	46.3	7.9	50.808
Total Phosphorus	mg/L	0.05	1.31	0.549	3.548
Specific Conductance	uS/cm	700	11800	7550	
Total Suspended Solids	mg/L	1	135	25	153.017
Aluminum	ug/L	30	2460	338	2.879
Boron	ug/L	20	1900	3610	23.734
Cadmium	ug/L	1	20	8.7	0.057
Copper	ug/L	50	50	13	0.081
Molybdenum	ug/L	205	410	165	1.049
Nickel	ug/L	20	480	178	1.142
Strontium	ug/L	7060	36000	14800	96.18
Zinc	ug/L	10	1580	215	1.353
Arsenic	ug/L	26	3860	188	1.222
Antimony	ug/L	1	130	15	0.097
Mercury	ug/L	0.1	6.1	1.24	0.008
Chloroform	ug/L	0.1	8.6	2.8	0.018
Methylene Chloride	ug/L	0.2	34.4	14.8	0.095
Styrene	ug/L	0.26	21.5	6.67	0.043
Bis(2-Ethylhexyl)Phthalate	ug/L	1.5	230	65	0.041
Total TCDD	pg/L	10	83	31	0.00000
Total PCDD	pg/L	10	50	20	0.00000
Octachlorodibenzo-p-dioxin	pg/L	20	65	33	0.00000
Oil and Grease	mg/L	1	20	4	23.531
Chloride, Unfiltered Reactive	mg/L	1240	8430	1770	11227.61
Fluoride, Unfiltered Reactive	mg/L	9.24	25.3	12.2	76.793
Sulphate, Unfiltered Reactive	mg/L	200	4000	2020	12748



**Table A3, Allied Chemicals Canada Inc.****Summary of Flows and Priority One Pollutants****MISA Control Point: PR0600****Description: HCl**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1	90	62.5	
COD	mg/L	23	17900	7290	440.341
Hydrogen Ion (pH)		0.1	7.8	2.45	
Nitrate & Nitrite	mg/L	0.04	1.23	0.715	0.034
Specific Conductance	uS/cm	290	685000	361000	
Aluminum	ug/L	280	14300	4860	0.099
Boron	ug/L	530	15000	5100	0.329
Cadmium	ug/L	1	36	11.8	0
Chromium	ug/L	20	140		0.003
Strontium	ug/L	180	1990	245	0.012
Zinc	ug/L	30	55		0.001
Arsenic	ug/L	7	674	245	0.005
Antimony	ug/L	1	134	67.8	0.005
Phenolics (4AAP)	ug/L	10	107	43	0.003
Bromomethane	ug/L	86	138000	38800	1.548
Bromoform	ug/L	25.8	8600	2740	0.121
Dibromochloromethane	ug/L	43	8600	3010	0.141
Chloromethane	ug/L	86	8600	3680	0.191
Chloroform	ug/L	8	700000	15500	0.991
Carbon Tetrachloride	ug/L	20	77000	3130	0.192
Methylene Chloride	ug/L	17	580000	18500	1.192
Trichlorofluoromethane	ug/L	17.2	370000	88700	5.512
Tetrachloroethylene	ug/L	43	8600	3010	0.141
Trichloroethylene	ug/L	25.8	21500	6250	0.256
Trans-1,2-Dichloroethylene	ug/L	25.8	8600	2740	0.121
Vinyl Chloride	ug/L	86	8600	3680	0.191
1,1-Dichloroethane	ug/L	8.6	8600	2470	0.101
1,1-Dichloroethylene	ug/L	25.8	8600	2740	0.121
1,1,2-Trichloroethane	ug/L	34.4	8600	2880	0.131
1,1,2,2-Tetrachloroethane	ug/L	25.8	12900	4230	0.184
1,2-Dichloroethane	ug/L	17.2	8600	2610	0.111
1,2-Dichloropropane	ug/L	8.6	8600	2470	0.101
cis-1,3-Dichloropropylene	ug/L	60.2	43000	12600	0.523
Trans-1,3-Dichloropropylene	ug/L	25.8	8600	2740	0.121
Chlorobenzene	ug/L	17.2	8600	2610	0.111
Ethylene Dibromide	ug/L	43	8600	2610	0.111
1,2-Dichlorobenzene	ug/L	34.4	21500	6390	0.266
1,3-Dichlorobenzene	ug/L	34.4	25800	7560	0.312
1,4-Dichlorobenzene	ug/L	17.2	43000	12000	0.473
Benzene	ug/L	8.6	8600	2470	0.101

For validated data  
see final table

**Table A3, Allied Chemicals Canada Inc.****Summary of Flows and Priority One Pollutants****MISA Control Point: PR0600****Description: HCl**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
m & p-xylene	ug/L	17.2	8600	2610	0.111
o-xylene	ug/L	43	8600	3010	0.141
Toluene	ug/L	2	8700	2360	0.144
Styrene	ug/L	51.6	21500	6660	0.287
Acrolein	ug/L	8600	43000	2920	1.168
Acrylonitrile	ug/L	6020	21500	15000	0.617
Bis(2-Ethylhexyl)Phthalate	ug/L	1.5	19	5210	0.001
Hexachlorobutadiene	ng/L	5	50000	5220	0.00033
Hexachlorocyclopentadiene	ng/L	5	50000	5320	0.00033
Hexachlorobenzene	ng/L	1	10000	1040	0.00007
Hexachloroethane	ng/L	13	180000	18400	0.00115
Octachlorostyrene	ng/L	1	10000	1040	0.00007
Pentachlorobenzene	ng/L	5	50000	5210	0.00033
2,4,5-Trichlorotoluene	ng/L	10	130000	13500	0.00084
1,2,3-Trichlorobenzene	ng/L	10	180000	18400	0.00115
1,2,3,4-Tetrachlorobenzene	ng/L	5	50000	5210	0.00033
1,2,3,5-Tetrachlorobenzene	ng/L	5	50000	5210	0.00033
1,2,4-Trichlorobenzene	ng/L	10	100000	10900	0.00068
1,2,4,5-Tetrachlorobenzene	ng/L	5	50000	5210	0.00033
Octachlorodibenzo-p-dioxin	pg/L	30	420	133	0.00000
Oil and Grease	mg/L	1	4.4	2.35	0.086
Chloride, Unfiltered Reactive	mg/L	29	263000	110000	7768.164
Fluoride, Unfiltered Reactive	mg/L	0.76	4480	2940	157.606
Sulphate, Unfiltered Reactive	mg/L	4	1200	441	25.947

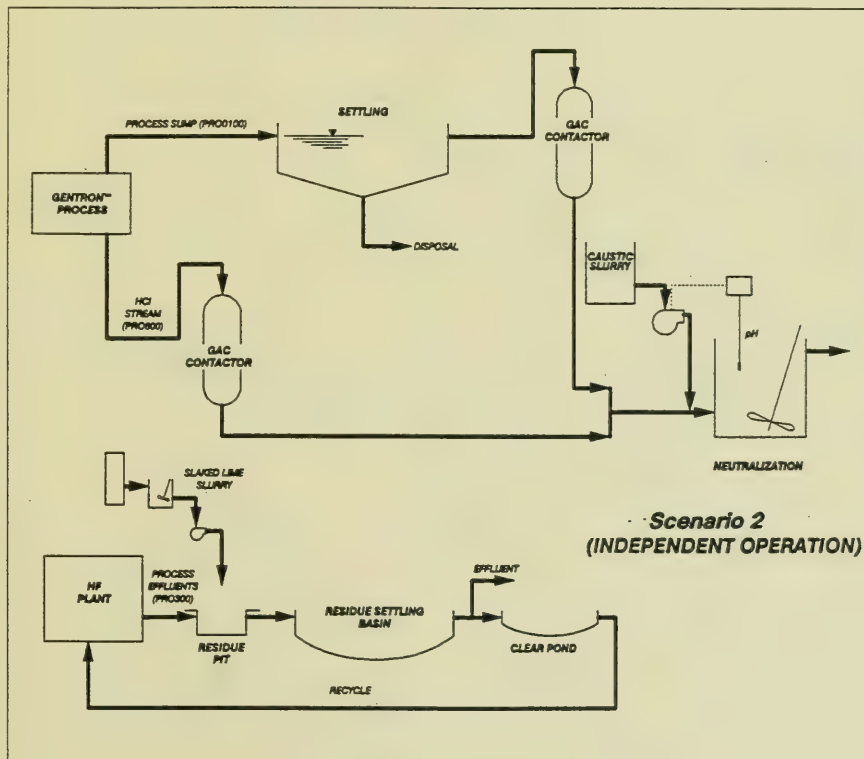
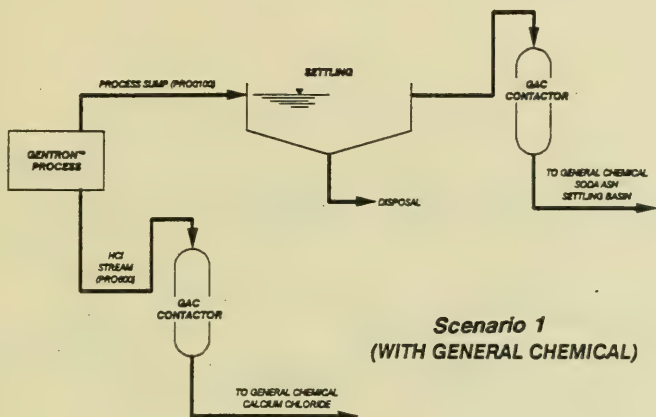
**Table A4, Allied Chemicals Canada Inc.**

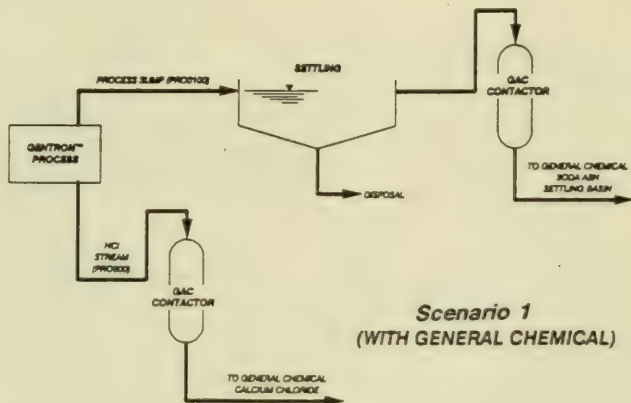
Summary of Flows and Priority One Pollutants

MISA Control Point: IN0800

Description: HCl

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	131676	277660	211900	
Nitrate & Nitrite	mg/L	0.12	1.4	0.805	164.043
Specific Conductance	uS/cm	176	21	263.4	
Aluminum	ug/L	40	34	391	80
Boron	ug/L	20	80	766.7	166
Strontium	ug/L	20	330	187.5	39.1
Zinc	ug/L	20	620	193	41.83
Mercury	ug/L	0.1	0.2	0.108	0.023
Oil and Grease	mg/L	1	5.4	2.4	530.3
Chloride, Unfiltered Reactive	mg/L	14	24	18.4	3536
Fluoride, Unfiltered Reactive	mg/L	0.19	0.53	0.369	73.4

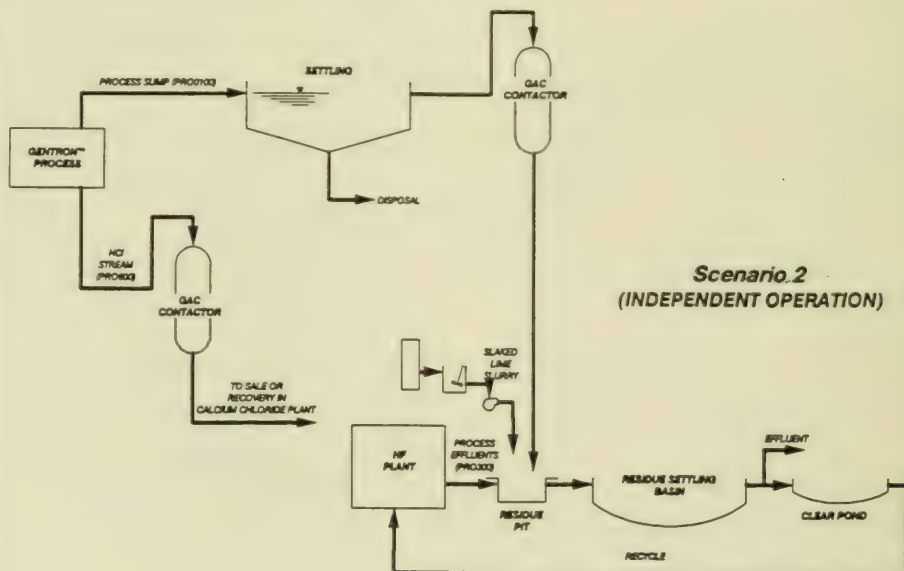




**Figure A2**  
**SCHEMATIC OF**  
**BAT OPTIONS 4 & 5**  
**FOR ALLIED CHEMICAL**



CH2M HILL  
ENGINEERING  
LTD.





				CONCENTRATIONS				LOADINGS				(kg/d)	
ATG	PARAMETER	RMDL	UNIT	PR 0100	PR 0300	PR 0600	IN 0600	PR 0100	PR 0300	PR 0600	IN 0600		
c	Total suspended solids	5	mg/L	245	25.7	12	17.2	53.9	160	0.591	53.2		
c	Hydrogen ion (pH)			8.75	7.89	2.45	8.04						
c	Specific conductance		uS/cm	3600	7600	361000	263						
c	DOC	0.5	mg/L	14.5	3.07	0.625	2.3	1.79	19.4	0.038	7.13		
c	TOC	5	mg/L	22	7.94	2.63	3.33	2.85	50.8	0.156	10.3		
c	Oil and grease	1	mg/L	2.93	3.68	2.35	2.38	0.629	23.5	0.086	7.37		
c	Ammonia plus Ammonium	0.25	mg/L	0.149	0.029	0.175	0.05	0.022	0.187	0.01	0.155		
c	Nitrate + Nitrite	0.25	mg/L	0.881	0.235	0.715	0.805	0.167	1.53	0.034	2.5		
c	Total Kjeldahl nitrogen	0.5	mg/L	0.518	0.765	0.45	0.387	0.084	4.99	0.015	1.2		
c	Total phosphorus	0.1	mg/L	0.057	0.549	0.04	0.13	0.015	3.55	0.003	0.404		
09	Aluminum	30	ug/L	485	438	4860	391	0.102	2.88	0.099	1.21		
09	Boron	50	ug/L	1810	3610	5100	767	0.431	23.7	0.329	2.38		
09	Cadmium	2	ug/L	9.83	8.67	11.8	1.92	0.002	0.057	—	0.006		
09	Chromium	20	ug/L	29.2	21.7	52.5	23.3	0.006	0.14	0.004	0.072		
09	Copper	10	ug/L	15	12.8	17.5	13.3	0.003	0.081	0.001	0.041		
09	Molybdenum	20	ug/L	67.5	165	62.5	20	0.016	1.05	0.004	0.062		
09	Nickel	20	ug/L	26.7	178	32.5	20	0.005	1.14	0.002	0.062		
09	Strontium	20	ug/L	607	14800	245	188	0.101	96.2	0.012	0.58		
09	Zinc	10	ug/L	71	215	55	193	0.011	1.35	0.002	0.599		
10	Antimony	5	ug/L	249	15.5	67.8		0.043	0.097	0.005			
10	Arsenic	5	ug/L	203	188	245		0.036	1.22	0.005			
10	Selenium	5	ug/L	2	2.75	4		—	0.017	—			
12	Mercury	0.1	ug/L	0.296	1.24	0.35	0.108	—	0.008	—			
14	Phenolics (4AAP)	2	ug/L	5.98	94	43.3	2.583	0.001	0.624	0.003	0.008		
16	1,1,2,2-Tetrachloroethane	4.3	ug/L	129	4.18	4230		0.019	0.027	0.184			
16	1,1,2-Trichloroethane	0.6	ug/L	125	2.7	2880		0.018	0.018	0.131			
16	1,1-Dichloroethane	0.8	ug/L	91.6	2.63	2470		0.013	0.017	0.100			
16	1,1-Dichloroethylene	2.8	ug/L	114	2.72	2740		0.016	0.018	0.121			
16	1,2-Dichlorobenzene	0.8	ug/L	246	6.73	6390		0.035	0.044	0.266			
16	1,2-Dichloroethane	1.4	ug/L	103	2.66	2610		0.015	0.017	0.111			
16	1,2-Dichloropropane	0.9	ug/L	91.6	2.64	2470		0.013	0.017	0.100			

Continued

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS					LOADINGS (kg/d)				
				PR 0100	PR 0300	PR 0600	IN 0800		PR 0100	PR 0300	PR 0600	IN 0800	
16	1,3-Dichlorobenzene	1.1	ug/L	286	7.9	7560			0.041	0.051	0.312		
16	1,4-Dichlorobenzene	1.7	ug/L	425	13	12000			0.061	0.084	0.472		
16	Bromoform	3.7	ug/L	114	2.76	2740			0.016	0.018	0.121		
16	Bromomethane	3.7	ug/L	1400	41.6	38800			0.201	0.268	1.55		
16	Carbon tetrachloride	1.3	ug/L	736	2.78	3130			0.106	0.018	0.195		
16	Chlorobenzene	0.7	ug/L	103	2.65	2610			0.015	0.017	0.111		
16	Chloroform	0.7	ug/L	4610	2.83	15500			0.792	0.018	0.991		
16	Chloromethane	3.7	ug/L	192	2.92	3660			0.027	0.019	0.191		
16	Cis-1,3-Dichloropropylene	1.4	ug/L	477	13.1	12600			0.067	0.085	0.523		
16	Dibromochloromethane	1.1	ug/L	136	2.85	3010			0.019	0.018	0.141		
16	Ethylene dibromide	1	ug/L	103	2.68	2610			0.015	0.017	0.111		
16	Methylene chloride	1.3	ug/L	389	14.8	18500	1.09		0.058	0.095	1.19	0.003	
16	Tetrachloroethylene	1.1	ug/L	136	2.78	3010			0.019	0.018	0.141		
16	Trans-1,2-Dichloroethylene	1.4	ug/L	114	2.69	2740			0.016	0.017	0.121		
16	Trans-1,3-Dichloropropylene	1.4	ug/L	114	2.69	2740			0.016	0.017	0.121		
16	Trichloroethylene	1.9	ug/L	235	6.57	6250			0.034	0.042	0.256		
16	Trichlorofluoromethane	1	ug/L	1240	2.88	86700			0.219	0.019	5.51		
16	Vinyl chloride	4	ug/L	192	2.93	3680			0.027	0.019	0.191		
17	Benzene	0.5	ug/L	91.6	2.63	2470			0.013	0.017	0.100		
17	Styrene	0.5	ug/L	288	6.67	6660			0.038	0.043	0.288		
17	Toluene	0.5	ug/L	102	2.73	2360			0.016	0.018	0.144		
17	m-Xylene and p-Xylene	1.1	ug/L	103	2.65	2610			0.015	0.017	0.111		
17	o-Xylene	0.5	ug/L	136	2.73	3010			0.019	0.018	0.141		
18	Acrolein	4	ug/L	1110	13.4	29200			0.139	0.087	1.17		
18	Acrylonitrile	4.2	ug/L	577	6.8	15000			0.072	0.044	0.617		
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	15.9	65.1	14.1			0.003	0.410	0.001		
19	Di-n-butyl phthalate	3.8	ug/L	4.03	6.8	12.1			0.001	0.044	0.001		
23	1,2,3,4-Tetrachlorobenzene	10	ng/L	219	5	5210			-	-	-		
23	1,2,3,5-Tetrachlorobenzene	10	ng/L	185	5	5210			-	-	-		
23	1,2,3-Trichlorobenzene	10	ng/L	368	10	18400			-	-	0.001		
23	1,2,4,5-Tetrachlorobenzene	10	ng/L	185	5	5210			-	-	-		
23	1,2,4-Trichlorobenzene	10	ng/L	1080	10	10900			-	-	0.001		
23	2,4,5-Trichlorotoluene	10	ng/L	445	10	13400			-	-	0.001		
23	Hexachlorobenzene	10	ng/L	2030	1.75	1040			-	-	-		

Continued

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS				LOADINGS (kg/d)			
				PR 0100	PR 0300	PR 0600	IN 0800	PR 0100	PR 0300	PR 0600	IN 0800
23	Hexachlorobutadiene	10	ng/L	205	5	5220	—	—	—	—	—
23	Hexachlorocyclopentadiene	10	ng/L	325	6.25	5320	—	—	—	—	—
23	Hexachloroethane	10	ng/L	1090	5	18400	—	—	—	0.001	—
23	Octachlorostyrene	10	ng/L	92.8	1	1040	—	—	—	—	—
23	Pentachlorobenzene	10	ng/L	183	5	5210	—	—	—	—	—
24	2,3,7,8 TCDD	20	pg/L	12.5	12.7	17.5	—	—	—	—	—
24	Octachlorodibenzo-p-dioxin	30	pg/L	197	33.2	133	—	—	—	—	—
24	Octachlorodibenzofuran	30	pg/L	1780	31	29.8	—	—	—	—	—
24	Total H7CDD	30	pg/L	30.3	24.5	29.3	—	—	—	—	—
24	Total PCDD	20	pg/L	14.7	20	17.5	—	—	—	—	—
24	Total TCDD	20	pg/L	17.5	31	25	—	—	—	—	—
98	Filflow		m3/d	207	6260	62.5	—	—	—	—	—
11	Chloride	2	mg/L	488	1770	110000	18.4	88.9	11200	7770	57
12	Fluoride	0.1	mg/L	44.9	12.2	2940	10	5.98	76.8	158	2.41
13	Sulphate	5	mg/L	54.8	2020	441	—	8.94	12700	25.9	—

Notes:

Measurement of ATG 16 and 18 parameters required dilution before analysis which may result in high detection limits.  
Values for ATG 16 and 18 parameters may therefore be higher than the actual amounts present.

Intake loadings have been calculated using reported concentration data and 3104 m3/day for flow rate.

This flow rate of 3104 m3/day is derived from 181 discharging days recorded for PR0300; i.e. 181/365 of PR0300 mean flow.

PR0100 is the "Effluent from the Genetron Collection Sump" and this is discharged to the Detroit River via General Chemical CO0100.

PR0300 is the "HF Bleed Effluent" which also discharged, on 181 days, to the Detroit River via General Chemical CO0100.

PR0600 is the effluent "Hydrochloric Acid Stream" which is used in calcium chloride manufacture with eventual water discharge to the Detroit River via General Chemical stream CO0200.



### **APPENDIX 3**

**Cabot Canada Ltd.**





# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### CABOT CANADA LTD.

#### 1.0 PLANT DESCRIPTION

The Cabot Canada Ltd. facility uses the furnace process to manufacture carbon black. The furnace process involves cracking aromatic tars and natural gas in the presence of air in a refractory lined furnace at 1,600 °C. The resulting carbon is pulverized, pelletized, dried and packaged or conveyed to a hopper car, ready for customer distribution.

The chlorinated intake water is supplied by Polysar Rubber Corporation at a rate of 2,227 m<sup>3</sup>/d. The intake water is used in the six scrubbers, in the laboratory, as boiler feed for steam production, as once through cooling water in the plant's air conditioners, for process wash water and in the formulation of the binder. The boiler make-up water is treated with a descaling chemical.

Details on the plant, processes and wastewater generation are presented in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Sources

The wastewater produced at Cabot Canada Ltd., including boiler blowdown, once through air conditioning cooling water, spent scrubber liquor, laboratory wastewater, wash water generated in process areas, and storm water is directed to the onsite wastewater treatment system at a rate of 2,070 m<sup>3</sup>/d. All sanitary wastewater is discharged to the sanitary sewer system to be treated at the Sarnia municipal wastewater treatment facility.

Storm water runoff from the process areas, boiler area, and the boiler blowdown passes through oil containment booms in storm water collection ditches and one of two gravity oil/water separators.

The oil separator effluent and other plant effluents are combined and collected in a large underground storage tank. The effluent from the storage tank is treated with an alum slurry enroute to the settling lagoon. After passing through the settling lagoon, the wastewater is filtered by gravity through a sand filter. The sand filter effluent is sampled prior to discharge to the Cole drain at MISA Control Point CO0100.

## 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at Cabot Canada Ltd.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed in the following discussion.

---

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

## **BAT Option 1**

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Appendix Table A2. Six rainbow trout tests and four *Daphnia magna* tests were carried out on samples taken at Control Point CO0100. Four trout samples were non-lethal, and the remaining samples had lethal concentrations of greater than 100 percent. All of the *Daphnia magna* samples were non-lethal. The existing wastewater management system at Cabot was defined as BAT Option 1, since the toxicity of Cabot's effluent ranges from slightly lethal to non-lethal.

## **BAT Option 2**

Under 40 CFR Part 458 of the U.S. Federal Register (July 1, 1989 Edition), Subpart A for the Carbon Black Furnace Process Subcategory, BAT was defined as "no discharge of process wastewater to navigable waters".

Currently, Cabot Canada Ltd. discharges process water from three sources including:

- Process area wash water.
- Laboratory wastewater.
- Spent scrubber liquor.

The rate of wash water generation was not available, nor was the level of contamination. The wastewater generated by the laboratory amounts to approximately 3.1 L/d and originates from the washing of glassware. The rate of the spent scrubber liquor generation averages to 0.715 to 1.43 m<sup>3</sup>/d. The spent scrubber liquor consists of water contaminated with particles of inert carbon (Ref. 2). Each of the six scrubbers is used about twice a month for five to ten minutes to clean the flue gas discharged from the furnace during the start-up of a production unit or during main unit filter maintenance.

Two options are available that would enable Cabot Canada Ltd. to achieve zero discharge in accordance with U.S. BAT including:

- 1) The current process could be altered such that process effluents are eliminated.
- 2) The treated plant effluent could be used in the process.

The second option has already been considered by Cabot, and was reported to be not feasible (Ref. 2). Review of the current practice at Columbian Chemicals Ltd., a carbon black facility which also uses the furnace process, suggests that Cabot could alter their process to eliminate process effluents. However, it is recognized that a detailed understanding of the process is required to confirm if zero-discharge of process effluents is achievable at Cabot. Therefore, it is recommended that Cabot Canada Ltd.

develop the details of BAT Option 2. The cost for equalization, pumping and distribution equipment to recycle the small volumes of effluents back to the process is estimated to be less than \$50,000. However, the complexity of this operation in terms of treatment requirements and process configuration must be determined by Cabot.

### **BAT Option 3**

Two Ontario carbon black plants using the furnace process were included in the Ontario Inorganic Chemical Sector and examined as part of this study, including Cabot Canada Ltd. and Columbian Chemicals Canada Ltd.

Columbian meets the definition of U.S. BAT, (i.e. zero-discharge of all process related wastewaters). All storm, process and cooling waters, within the Columbian production area, are retained and directed to sumps. From the sumps, water is recirculated to the process quench step where it is lost to the atmosphere as steam. Some non-process related wastewater flows from water treatment units (ion exchange demineralization, dealkalizing, softening, etc.) are discharged to the sanitary sewer. In contrast, Cabot treats plant effluents and storm water using gravity oil/water separation, chemical addition to promote coagulation (alum slurry), settling and gravity filtration.

In Table 1, a comparison of the origin of the effluents and the loading of process related contaminants based upon the daily nameplate production rates at the two carbon black facilities is presented. The effluent quality from the two facilities is comparable, except that the loading of total suspended solids (TSS) is higher in the Columbian effluent. Based upon the comparison of the effluent quality at the two facilities, the recommended BAT Option 3 is the existing wastewater management system at Cabot Canada Ltd.

### **BAT Option 4**

BAT Option 4 is intended to provide maximum overall water pollution control. The possible sources of "Priority 1" pollutants in Cabot's effluent include:

- Boiler blowdown.
- Once through air conditioning cooling water.
- Spent scrubber liquor.
- Laboratory wastewater.
- Wash water generated in process areas.
- Storm water

A large portion of the total suspended solids (TSS) in the final effluent (4.87 mg/L) is likely inert carbon particles. Removal of TSS to these low concentrations has been



achieved by coagulation, settling and filtration (Ref. 11). Technologies for further reduction of TSS may be used in specific non-industrial applications, however, no practical application of these technologies in treating industrial effluent below the TSS achieved at Cabot was identified in this study. Thus, recommendations for BAT Option 4 does not include further reduction of TSS.

**Table 1**  
**A Comparison of the Final Effluent Source and Quality**

Parameter	Facility	
	Cabot Canada Ltd. <sup>1</sup>	Columbian Chemicals Canada Ltd. <sup>2</sup>
Source of Effluent	<ul style="list-style-type: none"> <li>• boiler blowdown</li> <li>• air conditioner once through cooling water</li> <li>• spent scrubber liquor</li> <li>• laboratory wastewater</li> <li>• storm water runoff</li> <li>• process wash water</li> </ul>	<ul style="list-style-type: none"> <li>• storm water runoff</li> </ul>
Flow (m <sup>3</sup> /t of daily production)	9.44	2.04
TSS (g/t of daily production)	46.9	127
Oil/Grease (g/t of daily production)	11.3	7.07
Sulphate (g/t of daily production)	704	383
Sulphide (g/t of daily production)	0.44	0.37
Notes:		
1. Based on average loading data from MISA Control Point CO0100 at Cabot Canada Ltd.		
2. Based on average loading data from MISA Control Points ST0100 and ST0200 at Columbian Chemicals Canada Ltd.		

The sulphate (53 mg/L) may originate from plant processes, from the raw water, or from storm water runoff. Since the mean concentration of sulphate is not excessive, in that it is typical of levels found in raw water sources, sulphate reduction measures are not recommended.

Most of the oil and grease has been effectively removed by the wastewater treatment facility of Cabot. If further reduction from 1.24 mg/L of oil and grease is required, low levels of oil and grease may be removed from plant effluents using an oil absorption column, presented in the General Technology Report (Ref. 10). Alternatively pollution prevention activities such as best management practices could be exercised on the plant site.

The mean sulphide concentration in the final effluent was 30 µg/L based on two samples. A possible source of sulphide could be asphaltines in the decant oil which may contaminate the scrubber water. As well, the sulphides may originate from fugitive emissions washing into the final effluent with the storm water runoff. The method by which the sulphides enter the final effluent is unknown; therefore, an audit of the source should be considered. Reduction or elimination of sulphide in the final effluent

will be based on source controls through process changes such as improved air emission quality, materials substitution, best management practices or through storm water management.

A portion of the aluminum likely results from the wastewater treatment chemical, alum. Alum is added to the effluent, prior to settling and filtration, to promote solids removal by coagulation. It is not possible to identify the form of the aluminum present in the effluent (i.e. soluble or insoluble) from the MISA Monitoring Regulation data. However, since the effluent has already been treated in the settling/filtration system, it is likely that a large portion of the remaining aluminum is soluble.

If the levels of aluminum are perceived to be excessive, the preferred approach is to use an alternative coagulant such as ferric chloride, or a polymeric coagulant. Several polymeric coagulant blends have been developed to minimize alum carry-through (Ref. 4). The application rates of these products must be determined with jar testing.

Alternatively, additional chemical treatment of the wastewater could be considered to enhance the formation of insoluble aluminum complexes, so that these complexes could be removed by the settling/filtration system. The most common method of maximizing the formation of insoluble aluminum is by pH adjustment. A literature search ( Ref. 5, 6 and 7) revealed that the optimum pH range for formation of insoluble aluminum ranges from 5.4 to 7.3. During the 12 month MISA Monitoring Regulation period, the pH of Cabot's final effluent ranged from 6.3 to 9.17 with a mean pH of 8.00. Therefore, to optimize the formation of insoluble aluminum, the pH should be reduced by acid addition.

The addition of acid to maximize the removal of soluble aluminum would involve significant modifications including a separate chemical storage facility, a chemical feed system, a chemical feed control system and a new chemical hazard would be introduced to the site. This option should be considered only if the level of soluble aluminum is perceived to be significant, and consideration of other alternatives has been exhausted.

A review of the remaining contaminants detected in the final effluent indicates that most of these are not generated in the process, but may originate in raw water. These contaminants include various metals, nitrates and TKN, and chloride. Technologies for the removal of low levels of these contaminants present in the final effluent may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive global search carried out as part of this study did not identify practical applications of these technologies in treating industrial wastewater effluents with similar concentrations. Thus, BAT Option 4 does not include technologies for the removal of these contaminants.

Careful review of the processes, raw materials, products and chemicals used at the plant within the scope of this study, did not reveal a source for cyanide, an identified "Priority 1" pollutant. An audit of the possible sources of this contaminant is necessary, and reduction or elimination of this contaminant in the final effluent will be based on

source controls through process changes, materials substitution, or best management practices.

Based on the above discussion, BAT Option 4 is for Cabot to consider implementing a Source Identification and Control Study<sup>2</sup> for sulphide and cyanide. As well, if the levels of aluminum in the final effluent are perceived to be excessive, the use of alternative coagulants should be considered.

### **BAT Option 5**

In the discussion of BAT Option 2 and BAT Option 3, the issues surrounding zero discharge were addressed. Cabot Canada Ltd. must examine the feasibility of process alteration to achieve zero discharge and to provide cost, and design details.

### **Summary**

A summary of the BAT Options recommended for Cabot is presented in Table 2.

<b>Table 2</b> <b>Summary of BAT Options for Cabot Canada Ltd.</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Non-lethal effluents	No change to existing system.
2	U.S. BAT	To be provided by Cabot <sup>1</sup> .
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum pollution reduction.	Implement a Source Identification and Control Study for sulphide and cyanide. Consider alternative coagulants. <sup>2</sup>
5	Furthest toward zero discharge	Same as BAT Option 2.
<b>Notes:</b>		
1. Technologies to achieve U.S. BAT cannot be defined within the scope of this study.		
2. Only if aluminum in the effluent is perceived to be excessive.		

<sup>2</sup> Source Identification and Control Study involves an audit of the possible sources of this contaminant. Reduction or elimination of this contaminant in the final effluent may be based on source controls through process changes, materials substitution, improved air emission quality, best management practices, or through storm water management.

1. Inorganic Chemical Sector Plants Site Visit Report - Cabot Canada Ltd. March 19, 1991. (unpublished).
2. Telefax communication with Dr. Albert Lu of Cabot Canada. September 10, 1991.
3. U.S. Federal Register, 40 CFR Chapter 1, July 1, 1989 Edition.
4. Telephone communication and personal correspondence with Ken Reid of Dearborn Chemical Company Ltd. October 1991.
5. Letterman, R.D., Driscoll, C.T., and Fitch, D.E.. *Residual Aluminum in Filter Water*. AWWA Seminar Proceedings, *Influence of Coagulation on the Selection, Operation and Performance of Water Treatment Facilities*, 1987.
6. Nelco Chemical Company. *The Nalco Water Handbook*, McGraw-Hill Book Company: Toronto, 1979
7. Faust, S.D. and Osman M.A. *Chemistry of Water Treatment*. Butterworths: Toronto, 1983.
8. Snoeyink, Vernon and Jenkins, David. *Water Chemistry*. John Wiley & Sons: Toronto, 1980.
9. Ministry of the Environment. *Scientific Criteria Document for Development of Provincial Water Quality Objectives and Guidelines- Aluminum.*, ISBN 0-7729-4326-5. 1988.
10. General Technology Report, Sedimentation for TSS Removal.
11. Sister Plant Technology Report, Coagulation/Settling/Filtration Ponds at Cabot Canada Limited.
12. General Technology Report. Oil Removal by Absorption.
13. Drinking Water Surveillance Program, *Sarnia (Lambton County) Water Treatment Plant*. 1989 Annual Report.
14. Telephone conversation with William Fleming of Cabot Corporation, Atlanta, Georgia. June 1991.



**APPENDIX**  
**Tables**





**Table A1, CABOT CANADA**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100, Final effluent

Description: Filter Bed Effluent

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	335	4500	2070	
COD	mg/L	13	23	18	51.338
Cyanide	mg/L	0.001	0.037	0.004	0.008
Total Kjeldahl Nitrogen	mg/L	0.16	1.6	0.51	0.937
Nitrate & nitrite	mg/L	0.025	1.1	0.605	1.123
DOC	mg/L	0.8		5.05	5.956
Specific Conductance	us/cm	260	1000	750	
Total Suspended Solids	mg/L	4.2	65	4.87	10.283
Aluminum	ug/L	190	1600	661	1.391
Copper	ug/L	4	48	23.5	0.051
Strontium	ug/L	2	300	169	0.349
Zinc	ug/L	4	510	73.6	0.135
Sulphide	ug/L	30	30	30	0.096
Oil and Grease	mg/L	0.96	10	1.24	2.475
Chloride, Unfiltered Reactive	mg/L	14	430	127	213.352
Sulphate, Unfiltered Reactive	mg/L	41	65	53	154.518

**Table A2**  
**Summary of Acute Lethality Data from Dec 1989 to May 1990.**

Test Species	Number of Samples	Range of Data	Number of Non-Lethal Samples
Rainbow trout	6	> 100 % to non-lethal	4
<u>Daphnia magna</u>	4	all non-lethal	4

**Cabot Canada  
Samia**

		CONCENTRATIONS		LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	CO 0100	CO 0100
c	Total suspended solids	5	mg/L	4.89	10.9
c	Hydrogen ion (pH)			7.99	
c	Specific conductance		uS/cm	739	
c	DOC	0.5	mg/L	3.05	5.96
c	Oil and grease	1	mg/L	1.36	3.14
c	Ammonia plus Ammonium	0.25	mg/L	0.145	0.266
c	Nitrate+Nitrite	0.25	mg/L	0.605	1.12
c	Total Kjeldahl nitrogen	0.5	mg/L	0.51	0.936
c	Total phosphorus	0.1	mg/L	0.088	0.175
09	Aluminum	30	ug/L	661	1.39
09	Copper	10	ug/L	23.5	0.051
09	Strontium	20	ug/L	169	0.349
09	Zinc	10	ug/L	73.6	0.135
14	Phenolics (4AAP)	2	ug/L	1.5	0.004
15	Sulphide	20	ug/L	30	0.096
16	Chloroform	0.7	ug/L	1.1	0.005
18	Acrylonitrile	4.2	ug/L	4.2	0.017
23	Hexachlorocyclopentadiene	10	ng/L	7.35	—
2	Cyanide Total	0.005	mg/L	0.004	0.008
98	Ftflow		m3/d	2180	
I1	Chloride	2	mg/L	127	213
I2	Fluoride	0.1	mg/L	0.1	0.32
I3	Sulphate	5	mg/L	53	155

Notes:

CO0100 is the effluent stream "Discharge from Filter Bed".

This flows is discharged via the Cole Drain to the St. Clair River.





## **APPENDIX 4**

**Columbian Chemicals Canada Ltd.**



# **INORGANIC CHEMICAL SECTOR PLANTS**

## **REPORT ON BAT OPTIONS**

### **COLUMBIAN CHEMICALS**

#### **1.0 PLANT DESCRIPTION**

Columbian Chemicals Canada Ltd. manufactures carbons black using the furnace method. The feedstock, a "make oil" consisting of petroleum hydrocarbon, coal tar distillate and small amounts of caustic potash, is filtered and burned in furnaces to produce carbon black. Quench water cools the product and binder is added to form beads and pellets, which are dried, sized and stored for shipping. Details on the plant, processes and wastewater generation are provided in the associated site visit report (Ref. 1).

#### **2.0 WASTEWATER SOURCES AND QUALITY**

##### **2.1 Wastewater Sources**

All wastewater generated within the plant production area, including process wastewater and stormwater, is collected in trenches, settled in sumps and recycled back to the process to use as product quench, where it is lost as steam.

Several wastewater streams at the plant, including ion exchange regenerants, compressor cooling water, boiler blowdown and domestic sanitary wastewater are discharged to the municipal sanitary sewer for treatment at the Hamilton (Woodward) WPCP.

Two storm water streams were monitored under the MISA Monitoring Regulation at Columbian Chemicals. At MISA Control Point ST0100, runoff from the tank farm, truck loading and unloading areas, off-spec product storage areas and warehouse roof drains was monitored. Control Point ST0200 monitored runoff from a second tank farm, parking lot, rail car loading area, and plant office and maintenance buildings.

##### **2.2 Wastewater Flows and Quality**

Tables A1 and A2 in the Appendix presents average, maximum and minimum flow data and concentration data for those contaminants defined by the MOE as "Priority 1" for MISA Control Points ST0100 and ST0200 at Columbian. Based on information from the plant site visit, it appears that TSS and sulphide present in the effluent streams are a result of fugitive emissions.

In accordance with the study requirements, BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, meeting all of the following five criteria should be considered for each Ontario Inorganic Chemical Sector plant:

1. A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
2. A BAT option that is predicted to provide the maximum overall pollution reduction.
3. The BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
4. A BAT option that uses the best technology currently in use in Ontario.
5. A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Under 40 CFR Part 458 of the U.S. Federal Register (1989), the U.S. BAT defined for the Carbon Black Manufacturing Point Source Category, Subpart A - Furnace Process, was "no discharge of process wastewater pollutants to navigable waters". Stormwater runoff was not included in the definition of process wastewater. Existing wastewater management at Columbian results in no direct discharge of process wastewater, as well as storm water from process areas. Thus, the existing operation is already covered by all of the criteria noted above, and therefore, BAT options for wastewater generated at Columbian were not considered further.

Storm water runoff from outside of immediate production areas at Columbian, monitored at MISA Control Points ST0100 and ST0200, discharges directly to the receiving water. By study definition, BAT options would not be considered for storm water runoff streams. However, because a second Ontario carbon black plant, Cabot Canada Ltd., is demonstrating a treatment technology for removal of contaminants from storm water (and process effluents), the Ontario Ministry of the Environment has specifically requested that this technology be considered as a stormwater control option for Columbian. The technology at Cabot consists of coagulation, settling and granular filtration.

---

1

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control study at each site.

The storm water control option considered for Columbian Chemical includes a coagulation settling pond passive sand filter treatment system demonstrated at a "sister plant". A schematic of the treatment system is presented in Figure A1 while system details are provided in the sister plant report (Ref. 2).

Coagulant is added to wastewater in the pump discharge to the settling pond. The settling pond overflows by gravity to a second pond containing a layer of sand filter media above a layer of gravel containing perforated pipes. Filtered water exists through the pipes to a weir chamber, and overflows to the outfall pipe. The system operates at a constant rate in an on/off manner, based on the level of wastewater in a pump tank. Both ponds are clay lined. At Cabot, two systems in parallel are operated alternately, to allow cleaning without disruption in operation. The system, if implemented at Columbian, would treat only storm water and would not be in operation during winter months. Therefore, a single pond system would be sufficient.

Table 2 presents the basis for the hydraulic design of the proposed storm water treatment facility. Storm flows have been estimated using the Rational Formula and a five year return frequency design event. Two pumping facilities will be needed to pump flows to the head of the single filter pond. Total discharge design conditions will be 1,134 m<sup>3</sup>/h. Coagulant will be added to each forcemain when the pumps are operating. Figure A2 presents across-section view of the proposed facilities.

<b>Table 2</b> <b>Design Parameters for Stormwater Treatment Facility at Columbian Chemicals</b>		
Item	Capacity	Basis
Pumping from east outfall	747 m <sup>3</sup> /h	<ul style="list-style-type: none"> <li>• Manhole and submersible pump station.</li> <li>• Drainage area = 31,400 m<sup>2</sup></li> <li>• Runoff coefficient C = 0.5</li> <li>• 5 year, 30 minute storm.</li> </ul>
Pumping from west outfall	387 m <sup>3</sup> /h	<ul style="list-style-type: none"> <li>• Manhole and submersible pump station</li> <li>• Drainage area = 54,260 m<sup>2</sup></li> <li>• Runoff coefficient C = 0.15</li> <li>• 5 year, 30 minute storm.</li> </ul>
East pumping station forcemain to filter pond	350 m, 500 mm dia.	• Distance to estimated filter pond site.
West pumping station forcemain to filter pond	95 m, 35 mm dia.	• Distance to estimated filter pond site.
Filter pond	1,134 m <sup>3</sup> /h	
Filter pond plant outfall pipe	150 m, 800 mm dia.	• Treatment plant discharge rate.

Table 3 presents details of the filter design information.



<p align="center"><b>Table 3</b>  <b>Stormwater Pond Treatment System Design Details for Columbian Chemicals</b></p>	
<b>Item</b>	<b>Description</b>
<b>Settling Pond</b> <ul style="list-style-type: none"> <li>• Surface loading rate</li> <li>• Minimum water depth</li> </ul>	$69 \text{ m}^3/\text{m}^2\cdot\text{d}$ 0.7 m
<b>Passive Filter</b> <ul style="list-style-type: none"> <li>• Surface loading rate</li> <li>• Sand depth</li> <li>• Gravel Depth</li> </ul>	$92 \text{ m}^3/\text{m}^2\cdot\text{d}$ 45 cm 45 cm
<b>Sludge Generation</b> <ul style="list-style-type: none"> <li>• Total flow treated is mean precipitation x catchment area = <math>63,000 \text{ m}^3/\text{y}</math>.</li> <li>• Ninety percent removal of solids (average 45 mg/L influent TSS).</li> <li>• Total solids generated including TSS, coagulant and fouled sand medium = 7 t/y.</li> <li>• Mixed sludge @ 5% solids concentration.</li> </ul>	$250 \text{ m}^3/\text{y}$
Total land area required for treatment system	2,800 $\text{m}^2$

The total land area required for the treatment system is 2,800  $\text{m}^2$  assuming total pond depths of 3 m below the top of the berms, and berms have 2:1 sidewall slopes. It appears that there is adequate land area onsite between the tank farm and west storm ditch to situate the treatment system. If unspecified site specific factors limit the land availability, then a system consisting of concrete tanks could be considered. This would eliminate land requirements for berms, but substantially increase capital costs.

At Cabot, sludge from the ponds and a portion of sand from the filter is removed periodically and placed in a clay-lined sludge drying bed. Once dried, these solids are hauled off-site for disposal as a hazardous waste. Because of limited land area at Columbian, and low total volumes of sludge and wastes generated, it is assumed that waste sand and sludge would be hauled directly off-site.

Operating requirements for the treatments plant will include:

- Chemical coagulant
- Filter sand and sludge and disposal costs (for the purpose of costing, assumed annually)
- Electricity and maintenance
- Labour
- Sand replacement.

## Performance

The coagulation, settling, filtration system considered for Columbian is intended to reduce the concentrations of TSS in storm water. At Cabot, the treatment system is capable of achieving mean effluent TSS concentrations of 4.9 mg/L, although the influent concentration, and therefore, the removal efficiency is unknown. Removal efficiencies typical for coagulation/settling and filtration systems are presented in Table 4 and can be used as an approximate guide for the potential efficiency achievable by the pond treatment system.

Table 4 Typical Performance of Coagulation/Settling and Filtration Systems				
Technology	Effluent TSS Concentrations (mg/L)		Removal Efficiencies (%)	
	Range	Median	Range	Median
Coagulation/Settling	2.5-43	28	21->99	91
Filtration	<1-7,300	17	6-99	76
Source: Ref. 3				

The use of the TSS removal system will also reduce the levels of any contaminants associated with TSS, which may include; ammonia, TKN and nitrate, metals and sulphides. The influent concentration of the contaminants at Cabot has not been measured, and therefore, it is not possible to determine the Cabot treatment system removal efficiency directly.

The mean concentrations of those contaminants considered by the MOE to be "Priority 1" in storm water effluents from Columbian are compared to the effluent quality obtained from the Cabot treatment system in Table 5. This data is presented for information purposes and should be used with caution, since effluent concentrations at Cabot are not only a result of treatment effectiveness also depend on the unknown influent quality.

For the first six months of MISA monitoring, Cabot produced an effluent low in suspended solids and nutrients. The effluent was also non-lethal to rainbow trout and Daphnia magna. The toxicity of Columbian storm water discharges were not monitored.

## Capital Costs

Estimated capital costs of the main components of the treatment system are presented in Table 6. A total estimated cost of \$1.7 million includes implementation of the treat-

ment system, pumping stations and forcemains, and outfall piping. The cost for a new effluent monitoring station was not included.

<b>Table 5</b> <b>Estimated Performance of BAT Option 1 Applied to Columbian Storm Water Effluents</b>					
Parameter	Units	Average Columbian Storm Water Concentration <sup>1</sup>	Cabot Effluent Concentration <sup>2,3</sup>		
			Minimum	Maximum	Mean
Ammonia-N	mg/L	1.1	0.03	1.1	0.15
TKN	mg/L	1.8	0.16	1.6	0.51
Nitrate + Nitrite	mg/L	0.89	0.025	1.1	0.61
DOC	mg/L	7.5	0.8	13	3.1
TOC	mg/L	9.3	n.d. <sup>4</sup>	n.d.	n.d.
Specific Conductance	mg/L	922	260	6,100	750
TSS	mg/L	45	4.2	65	4.9
Al	µg/L	938	190	1,600	661
B	µg/L	175	15	48	33
Cu	µg/L	15	4	48	24
Sn	µg/L	328	2	300	169
Zn	µg/L	433	4	510	74
Phenolics	µg/L	105	1	8	1.5
Sulphide	mg/L	292	30	30	30
Oil & Grease	mg/L	3.4	196	10	1.3
Chloride	mg/L	81	14	430	127
Sulphate	mg/L	234	41	65	53
Acute toxicity					
- Rainbow trout	mg/L	n.d.	-	-	non-lethal
- Daphnia magna	mg/L	n.d.	-	-	non-lethal
Notes:					
1. Average of means for Columbian Control Points 0100 and 0200 assuming a flow proportioning of 1:2.2 (based on calculated pump flow rates presented in Table 2).					
2. 12 month MISA Monitoring data from Cabot filter discharge.					
3. Data does not necessarily reflect concentrations achievable at Columbian.					

## Operating Costs

The estimated annual costs of operating the runoff treatment system at Columbian are presented in Table 7.

Cabot has requested that the type of chemical coagulant they used be treated as confidential information. Costs were based on their reported costs. Other operating costs include labour and maintenance, were also based on Cabot's reported costs. It was assumed that 250 m<sup>3</sup> of sludge and sand would be removed from the ponds annually and disposed off-site.

Estimated annual operating costs are approximately \$97,000.

**Table 6**  
**Estimated Capital Cost Components of Storm Water Pond Treatment System**  
**(ENR CCI 6343)**

Component	Capital Cost (\$1991)
Treatment System	\$780,000
East Outfall Pumping Station	\$320,000
West Outfall Pumping Station	\$260,000
Forcemain	\$260,000
Outfall	\$110,000
<b>Total Capital Cost<sup>1</sup></b>	<b>\$1,720,000</b>
Notes:	
1. Includes engineering installation, estimating contingency and G.S.T. based upon data supplied by Cabot Canada.	

**Table 7**  
**Estimated Annual Operating Costs**

Component	Annual Operating Cost (\$1991)
Coagulant	\$300
Labour (including coagulant and sludge handling)	\$6,000
Sludge and sand disposal	\$80,000
Energy and Maintenance	\$8,000
Sand replacement	\$3,000
<b>Total (rounded)</b>	<b>\$97,000</b>

## 5.0 SUMMARY OF COST AND PERFORMANCE

Table 8 presents a summary of the estimated costs and performance of the storm water pond treatment system if it were implemented at Columbian Chemicals.

## 6.0 REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report - Columbian Chemicals Canada Ltd. March 18, 1991. (unpublished).
2. Sister Plant Technology Report - Coagulation/Settling/Filtration Ponds at Cabot Canada Ltd.

3. U.S. EPA, 1981. Treatability Manual, Volume III: Technologies for the Control/Removal of Pollutants. EPA report No. EPA 600/2-82-0010.

<b>Table 8</b> <b>Summary of Estimated Cost and Performance</b>	
<b>Component</b>	<b>Estimated Result</b>
<b>Costs</b>	
Capital Cost	\$1,720,000
Annual Operating Cost	\$97,000
<b>Quality Parameter</b>	<b>Effluent Concentration</b>
TSS	<5 mg/L <sup>1</sup>
Notes:	
1. Based on typical removal efficiencies for coagulation/sedimentation/filtration systems.	



## **APPENDIX**

### **Figures and Tables**



**Table A1, Columbian Chemicals Canada,**

**Summary of Flows and Priority One Pollutants**

**MISA Control Point: ST0100**

**Description: West Outfall**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0.027	848	182	
Ammonia Plus Ammonium	mg/L	0.17	4.2	1.26	0.139
Total Kjeldahl Nitrogen	mg/L	0.7	6.7	2.1	0.244
Nitrate and Nitrite	mg/L	0.68	1.5	1.14	0.188
DOC	mg/L	2.1	11	6.7	0.92
TOC	mg/L	5.1	11	8	1.39
Specific Conductance	uS/cm	450	1300	734	
Total Suspended Solids	mg/L	9	200	68	15.934
Aluminum	ug/L	280	4200	1420	0.413
Boron	ug/L	62	330	182	0.026
Copper	ug/L	5	46	16	0.005
Strontium	ug/L	140	450	292	0.044
Zinc	ug/L	52	700	186	0.048
Phenolics (4AAP)	ug/L	11	110	14	0.003
Sulphide	ug/L	19	1100	210	0.024
Oil and Grease	mg/L	2.8	11	4.7	0.894
Chloride, Unfiltered Reactive	mg/L	16	130	54	6.965
Sulphate, Unfiltered Reactive	mg/L	80	260	164	24.801

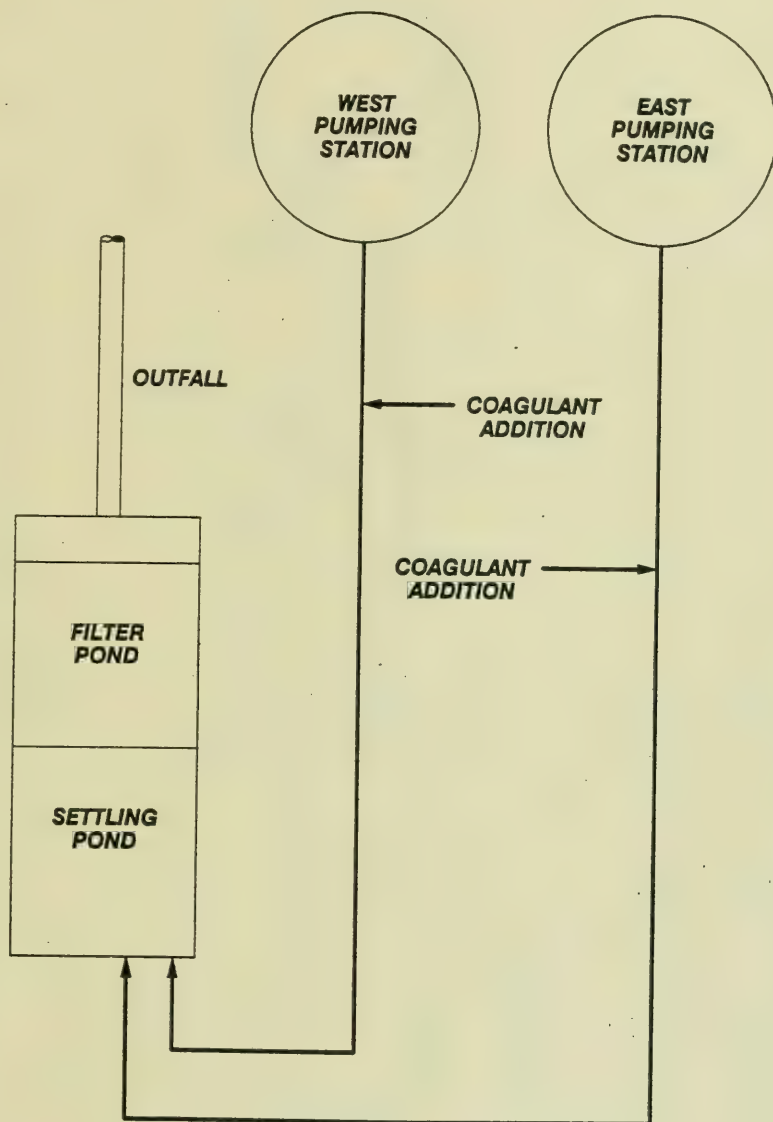
**Table A2, Columbian Chemicals Canada**

**Summary of Flows and Priority One Pollutants**

**MISA Control Point: ST0200**

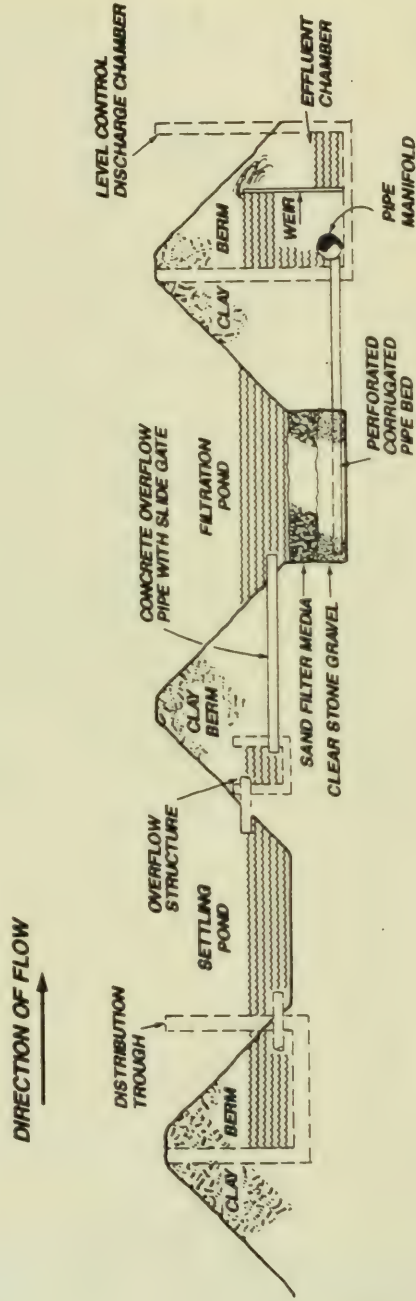
**Description: East Outfall**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0.759	1160	322	
Ammonia Plus Ammonium	mg/L	0.32	2.4	1.06	0.272
Total Kjeldahl Nitrogen	mg/L	1	3.1	1.7	0.496
Nitrate and Nitrite	mg/L	0.48	1.3	0.78	0.239
DOC	mg/L	3.5	15	7.8	1.929
TOC	mg/L	4.9	29	9.9	2.629
Total Phosphorus	mg/L	0.069	0.64	0.138	0.035
Specific Conductance	uS/cm	510	1700	1010	
Total Suspended Solids	mg/L	20	88	34	15.317
Aluminum	ug/L	170	1200	715	0.285
Boron	ug/L	96	280	173	0.047
Copper	ug/L	2	40	15	0.006
Strontium	ug/L	220	550	345	0.095
Zinc	ug/L	56	5500	547	0.211
Phenolics (4AAP)	ug/L	4	1100	147	0.03
Sulphide	ug/L	19	1600	331	0.068
Oil and Grease	mg/L	1.3	5.1	2.8	0.85
Chloride, Unfiltered Reactive	mg/L	24	210	93	21.785
Sulphate, Unfiltered Reactive	mg/L	96	430	267	69.612



**Figure A1**  
**SCHEMATIC OF PROPOSED**  
**POND SYSTEM AT COLUMBIAN**





**Figure A2**  
**COAGULATION/SETTLING/FILTRATION PONDS**  
**CROSS SECTIONAL VIEW**  
*(not to scale)*

## **APPENDIX 5**

**Conpak, A Business Unit of ICI Canada Inc.**



**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
CONPAK, A BUSINESS UNIT OF ICI CANADA INC.**

**1.0            PLANT DESCRIPTION**

Conpak is a filling and packaging facility for a number of products including:

- Compressed gases
  - Chlorine
  - Sulphur dioxide
  - Anhydrous ammonia
  
- Liquids
  - Sulphuric acid
  - Hydrochloric acid
  - Caustic soda
  - Caustic potash
  - Ammonium hydroxide
  - Hydrogen peroxide
  - Nitric acid
  - Acetic acid
  - Sodium hypochlorite
  - Hydrofluorosilicic acid

Intake water, supplied by the City of Cornwall is used for the following purposes:

- Product dilution
- Container washing
- Floor washing and equipment washdowns
- Vent gas scrubbing

Most wastewater from the plant site is collected in a sump which contains two neutralization tanks which are connected in series. Wastewater then flows to an effluent check tank prior to discharge. Further details on the plant processes and wastewater generation are provided in the site visit report (Ref. 1).

## **2.0                    WASTEWATER SOURCES AND QUALITY**

### **2.1                    Wastewater Sources**

Effluents from the neutralization check tanks are batch discharged and during the MISA Monitoring Regulation were monitored as MISA Control Point BA0100. This was the only monitoring point for the MISA program. Operations contributing wastewater to this control point are:

- Container washing
- Floor washing and equipment washdowns
- Hydrostatic testing of containers
- Caustic scrubber
- Common (water) scrubber
- Compressor condensate
- Valve cleaning bath.

Groundwater infiltration in the effluent collection sump is suspected to also contribute flows to BA0100. Other wastewater sources, including once through non-contact cooling water, pump seal water and storm water, were not monitored during the MISA monitoring period.

### **2.2                    Wastewater Flows and Quality**

Table A1 in the Appendix presents average, maximum and minimum flow and concentration data as well as average daily loadings for those contaminants defined by the Ministry of the Environment as "Priority 1" for MISA Control Point BA0100.

## **3.0                    RATIONALE FOR SELECTION OF BAT OPTIONS**

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.



- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

### **BAT Option 1**

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Appendix Table A2. Six rainbow trout tests and five Daphnia magna tests were carried out on samples taken at Control Point BA0100. The toxicity of the trout samples ranged from 14 percent to non-lethal with only one non-lethal sample. None of the Daphnia magna tests were non-lethal. The Daphnia magna lethal concentration results ranged from 11.5 percent to greater than 100 percent.

Several contaminants may be directly related to this lethality, including ammonia, pH and extreme values of TSS. In addition, the cumulative effects of several heavy metals may be playing a role, including cadmium, copper, nickel, lead and zinc. While several chlorinated hydrocarbons are "Priority 1" parameters, these are not believed to be contributing to acute lethality since similar concentrations of the majority of these compounds in the final effluent at nearby ICI Canada Inc. (Cornwall) produced non-lethal results. Therefore, BAT Option 1 consists of measures to better control pH, TSS, heavy metals and ammonia.

Source control of these contaminants does not appear to be a viable alternative since ammonia is a process material and heavy metals may be contaminants cleaned out of used containers or which originate in the valve cleaning bath. Similarly, pH and TSS excursions may be an unavoidable result of container and valve cleaning.

It should also be noted that the effluent may contain residual chlorine from the cleaning of sodium hypochlorite containers, but it is not possible to establish whether this is contributing to lethality.

The most appropriate technology for the combined control of TSS, heavy metals and pH is lime addition followed by sedimentation and filtration. This technology has several advantages in this case, including:

- Removal of dissolved heavy metals through the formation of insoluble metal hydroxides.
- Improved TSS removal over settling alone since lime addition also provides for coagulation.
- pH control through neutralization of lime treated effluents.
- Incidental removal of phosphorus as insoluble hydroxylapatite.

One of the main disadvantages of this process is the handling of the large amounts of sludge generated. Dewatering of this sludge prior to disposal may be required. The resulting dewatering effluent can be recycled to the lime addition step.

Several technologies are available for reduction of ammonia at the levels present in Conpak effluents, including:

- Ion exchange
- Break point chlorination
- Air stripping
- Biological nitrification-denitrification.

### Air Stripping

The U.S. EPA (Ref. 2) reported that better than 90 percent ammonia removal was achievable using air stripping, resulting in effluent concentrations of less than 5 mg/L.

The air stripping process involves raising the pH of the water to 10.8 to 11.5 with lime to convert all ammonia to ammonium, formation and reformation of water droplets in a stripping tower, and providing air water contact and droplet agitation to enable transfer of ammonia to air, which is released to the atmosphere.

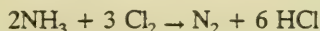
Several problems associated with air stripping have been identified as follows (Ref. 2, 3, 4):

- Low performance efficiencies in cold weather.
- High operating costs because of intense energy requirements.
- Calcium carbonate scaling as a result of lime addition.
- Cross media pollutant transfer; the ammonia is released to the atmosphere. Although technologies for ammonia recovery from air exist, they considerably increase the complexity and cost of the system.

On the basis of the above points, air stripping was not considered to be a demonstrated, practical control technology for treating the Conpak effluent stream.

### **Breakpoint Chlorination**

Breakpoint chlorination is the oxidation of ammonia with chlorine to result in the ultimate formation of nitrogen gas, following the overall reaction:



Theoretically, 7.6 mg/L of chlorine ( $\text{Cl}_2$ ) are required to oxidize 1 mg/L of ammonia-nitrogen.

Breakpoint chlorination has a long history of use in the chlorination of potable water supplies. It has also been used in the U.S. for minimizing the levels of un-ionized ammonia in effluents from other nitrogen removal technologies. However, several problems are potentially associated with the use of this technology in industrial wastewater treatment, including:

- Nitrate and nitrogen trichloride may be produced in the breakpoint chlorination reactions. Nitrate levels are already substantial at Conpak, while nitrogen trichloride exhibits a strong chlorinous odour, making its formation undesirable.
- Trihalomethanes and other chlorinated pollutants may be formed.
- Total dissolved solids levels may increase.
- Neutralization may be required to increase the pH after treatment. In addition, a dechlorination process to remove toxic chlorine residuals is required. Additional treatment steps increase the complexity of the system.

- Careful control of pH is critical to the performance of the process and to minimize nitrogen trichloride formation.

Based on the above potential problems associated with breakpoint chlorination, it is not a recommended technology for reducing ammonia levels in Conpak effluents.

### Ion Exchange

Selective ion exchange is a high-efficiency ammonia removal process for streams containing low TDS and ammonia concentrations. The waste stream is passed through a bed of ion exchange resin and functional groups attached to the resin exchange with ammonium ions in solution. Conventional ion exchange resins are not suitable for ammonia removal because most ions exchange preferentially to the ammonium ion.

However, this limitation is overcome by using an exchange resin selective for ammonium, such as clinoptilolite, a common material found in bentonite deposits which removes ammonium ions from water preferentially to other cations.

The optimum exchange pH ranges from 4 to 8. Lower values result in excess hydrogen ions competing with the  $\text{NH}_4^+$  for exchange. At a high pH,  $\text{NH}_4^+$  is predominantly converted to  $\text{NH}_3$  which will not exchange on the media. The process is insensitive to temperature fluctuations, but becomes less effective as ionic strength (TDS concentration) increases due to the effect of competing cation concentrations on the capacity of the media for ammonium (Ref. 5).

The exchange column can be regenerated with a sodium or calcium salt solution and the nitrogen can be recovered from the regenerant by air stripping, steam stripping, or electrolytic treatment.

Reported applications of selective ion exchange for ammonia removal include the treatment of municipal wastewaters having ammonia concentrations of about 25 mg/L. The U.S. EPA suggested ion exchange as an alternative treatment process to achieving BAT effluent limits in the nitrogen fertilizer industry (Ref. 2). In the global search carried out for this study, it was found that ion exchange was implemented in the 1970s at more than 10 nitrogen fertilizer facilities. However, currently only one process is remaining in operation. Operating problems that were encountered resulted in the discontinuation of the use of this process<sup>2</sup> (Ref. 6). Based on these problems, this process is not recommended for Conpak effluents.

---

<sup>2</sup>

Details on operating problems collected by SAIC are currently unavailable.



## **Biological Ammonia Removal**

Biological ammonia removal is the natural conversion of ammonia to nitrate, and nitrate to molecular nitrogen in a two stage process. The first stage, nitrification, takes place under aerobic conditions, while the second stage denitrification is anoxic, and must have a carbon source (typically methanol). Both suspended growth and fixed film systems are available. Details on the process are provided in a general technology report (Ref. 7).

Biological ammonia removal has been applied to treating ammonia nitrogen levels in industrial wastewaters with 30 to 700 mg/L (Ref. 7) and is recommended for the reduction of both ammonia and nitrate levels in Conpak effluents.

In summary, BAT Option 1 for Conpak effluents includes lime addition with sedimentation and filtration followed by biological nitrification/denitrification for the control of pH, TSS, heavy metals and nitrogen compounds. Further details on the components, performance and costs of this treatment system appear in Section 4.1.

## **BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 edition), BAT and effluent limitations were not defined for plants which package liquid and compressed gas inorganic chemical products. Thus, a BAT Option 2 was not defined for Conpak.

## **BAT Option 3**

One other plant in the Ontario Inorganic Chemical Sector packages acids (Sulco Chemicals Limited in Elmira). This plant is not directly comparable to Conpak for two major reasons:

- Over 95% of wastewater flows at Sulco do not originate from the packaging operation.
- The only products packaged at Sulco are inorganic acids.

However, both plants require control of pH and TSS. Sulco's treatment system consists of the use of sodium carbonate addition followed by settling in ponds and cloth bag filtration. The system operates on a continuous basis and effluent is monitored for pH. Alarms indicate when pH is outside the appropriate range for discharge and chemical addition is adjusted accordingly.

Conpak could achieve comparable treatment through the use of the recommended lime treatment system coupled with a settling/filtration system equivalent to that described in



the sister plant technology report for Cabot Canada Limited (Ref. 8). Therefore, BAT Option 3 is the use of this technology as described in Section 4.2.

#### **BAT Option 4**

BAT Option 4 includes recommendations for the maximum removal of "Priority 1" parameters. In the case of Conpak, BAT Option 4 includes technologies from both BAT Options 1 and 3 for the maximum removal of acutely lethal contaminants, such as pH, TSS, heavy metals (cadmium, copper, lead, nickel and zinc) and ammonia. These technologies are:

- Lime addition followed by settling and pH adjustment as well as possible sludge dewatering
- Filtration
- Biological nitrification/denitrification

These technologies will provide some incidental removal of a number of additional "Priority 1" parameters at Conpak including:

- Phosphorus
- Volatile chlorinated hydrocarbons
- COD
- DOC and TOC
- Phenolics
- Oil and grease

The remaining "Priority 1" parameters must also be addressed under this option. Careful review of the process and quality of effluents (Table A1) at the plant indicated that a number of contaminants are present at levels which are consistent with surface water quality in Ontario, including:

- Aluminum
- Boron
- Cobalt
- Chromium
- Strontium
- Thallium
- Arsenic
- Antimony
- Selenium

Technologies for the removal of these low levels of contaminants may be available and have been used in specific applications (e.g. drinking water treatment). However, an

exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations.

At the relatively low levels present, oil and grease and phenolics may be contributed from spills to floor drains during equipment maintenance and similar tasks. Management practices for source control is the recommended approach to further reduce oil and grease and phenolics loadings in effluents. These efforts should also reduce DOC and TOC levels.

The remaining "Priority 1" parameters at Conpak include volatile and non-volatile chlorinated hydrocarbons and mercury. The source of these contaminants is not clear and should be established prior to developing treatment options.

Volatile chlorinated hydrocarbons may be formed during contact of chlorine or hypochlorite containers with solvents or other oil and grease sources. They could also possibly be contaminants in the used containers returned to the plant for refilling. However, it should be noted that the effluent is suspected to contain groundwater which has infiltrated the sump where effluent is collected. Approximately two-thirds of the "Priority 1" chlorinated hydrocarbons, both volatile and non-volatile, were also "Priority 1" contaminants in effluents at the nearby ICI Cornwall plant. This suggests possible site and/or groundwater contamination in the area. A source identification and control study should be conducted for chlorinated hydrocarbons, including possible ground water concerns. Source control measures will likely be the most effective control technology for chlorinated hydrocarbons; however, some incidental removal of volatile species may occur in biological nitrification/denitrification through losses to the atmosphere.

No source of mercury could be firmly established, although nearby ICI Canada Inc. (Cornwall) is a chlor-alkali plant using the mercury cell process. Once again, a source identification and control study is recommended. It should be noted that effective removal of both mercury and chlorinated hydrocarbons may be achieved through powdered activated carbon (PAC) addition to the nitrification/denitrification system. However, this option would be recommended only if source identification and control failed to control these contaminants since it introduces increased operational complexity and additional treatment residuals requiring management.

Dissolved solids such as chloride, fluoride and sulphate are present in Conpak effluents at levels which are only somewhat elevated but which are treatable. A somewhat unique opportunity exists for treatment of these dissolved solids in Conpak effluents. BAT options for the nearby ICI Cornwall plant include concentration and drying of the plant effluent wastewater stream (Ref. 9). This option is proposed for effluent reaching MISA Control Point PR0400 at ICI and is sized for 220 m<sup>3</sup>/d. In addition, recycling of this wastewater to the chlor-alkali process is proposed.

Thus BAT Option 4 for Conpak includes sending effluent to ICI Cornwall for further treatment of dissolved solids (TDS). In order that the amount of wastewater to be treated for TDS removal will be minimal, recycling of wastewater within Conpak should occur. This would involve recycling effluent from the nitrification/denitrification step as washwater for container cleaning. However, since 100% recycle will not be achieved, it is estimated that the amount of effluent sent for further treatment at ICI Cornwall would be approximately 10 m<sup>3</sup>/d. This flow is not significant compared to the 220 m<sup>3</sup>/d being treated at ICI and will not significantly affect the performance and cost of treatment at ICI.

In summary, BAT Option 4 consists of the following technologies:

- Lime addition followed by settling and pH adjustment as well as sludge dewatering for control of TSS and heavy metals
- Filtration for control of TSS and heavy metals
- Biological nitrification/denitrification for control of nitrogen compounds
- Management practices for control of oil and grease and phenolics
- Recycle of treated wastewater to process
- Treatment of chloride, fluoride and sulphate using facilities proposed as BAT Options at ICI Cornwall

This option is discussed in further detail in Section 4.3.

### **BAT Option 5**

BAT Option 5 includes technologies which bring the plant furthest toward zero-discharge. For Conpak, the proposed use of treatment facilities at ICI Cornwall under BAT Option 4 necessitated maximum reuse and recycling of wastewater. Thus, BAT Option 5 is the same as BAT Option 4 in this case.

### **Summary**

Table 1 presents a summary of BAT Options defined for Conpak.

## **4.0      BAT OPTIONS**

BAT Option 2 was not defined for Conpak and BAT Option 5 is the same as BAT Option 4 for this plant. BAT Options 1, 3 and 4 are described below.

## 4.1

### BAT Option 1

#### Description

BAT Option 1 consists of two technologies:

<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents.	<ul style="list-style-type: none"> <li>• Lime addition, sedimentation and filtration</li> <li>• Biological nitrification/ denitrification.</li> </ul>
2	U.S. BAT.	<ul style="list-style-type: none"> <li>• No U.S. BAT defined.</li> </ul>
3	Best demonstrated in Ontario.	<ul style="list-style-type: none"> <li>• Lime addition and sedimentation.</li> <li>• Filtration.</li> </ul>
4	Maximum reduction of pollutants.	<ul style="list-style-type: none"> <li>• Lime addition and sedimentation.</li> <li>• Filtration.</li> <li>• Biological nitrification/ denitrification.</li> <li>• Management practices for oil and grease and phenolics.</li> <li>• Recycle of treated wastewater to process.</li> <li>• TDS removal at ICI Cornwall.</li> </ul>
5	Furthest toward zero-discharge of pollutants.	<ul style="list-style-type: none"> <li>• Same as BAT Option 4.</li> </ul>

- Lime addition, settling and filtration similar to the system described in the sister plant technology report for Cabot Canada Limited (Ref. 8). The pH of the wastewater is raised to 9 to 11.5 through the in-line addition of lime. This results in the precipitation of metals. Optimal pH for metal removal would have to be determined in a treatability study. Solids are settled in the settling pond which follows. After settling, the effluent passes through a passive sand filter which is required to remove metals to below their current levels. The effluent from the filter is neutralized, through the in-line addition of sulphuric acid, to a pH of 7. Neutral pH is required for the subsequent nitrification-denitrification step. This treatment system also provides flow equalization for downstream treatment.
- Biological nitrogen removal using nitrification-denitrification as described in a general technology report (Ref. 7). Ammonia and nitrate levels are reduced through biological nitrification-denitrification. The system consists of coupled biological fluidized bed reactors. The nitrification unit is supplied with pure oxygen, while the denitrification unit may require the addition of methanol as a supplemental carbon source.



## Performance

The projected performance of the implementation of BAT Option 1 is presented in Table 2. It should be noted that projected performance is based on reported median removal efficiencies (Ref. 10) for lime addition/sedimentation/filtration but that only treatability studies on the Conpak effluent will determine achievable concentrations.

<b>Table 2</b> <b>Projected Performance of Implementing BAT Option 1</b>					
Technology	Contaminant	Existing		Projected <sup>(1)</sup>	
		Concentration (mg/L)	Loading (kg/d)	Concentration (mg/L)	Loading (kg/d)
Lime Addition/Sedimentation/Filtration/pH Adjustment	TSS	83	3.2	8.3	0.32
	Cadmium	0.024	0.001	0.003	<0.001
	Copper	0.684	0.027	0.048	0.002
	Lead	0.734	0.029	0.125	0.005
	Nickel	0.240	0.009	0.060	0.002
	Zinc	0.188	0.007	0.013	<0.001
Nitrification/Denitrification	Ammonia-nitrogen	53	1.5	0.53	0.015
	Nitrate-nitrogen	57	1.8	0.57	0.018
Notes:					
1. Based on median removal efficiencies reported in Ref. 10 for lime addition and in Ref. 7 for nitrification/denitrification.					

## Costs

Capital and operating costs for implementing BAT Option 1 are summarized in Table 3. Costs for the lime addition/settling/filtration/pH adjustment system are based on information from Ref. 8 and include the following items:

- Lime storage and metering system
- Twin settling and filtration ponds
- Associated piping and overflow structures
- 35 percent installation
- 30 percent contingency allowance
- 15 percent engineering
- 7 percent G.S.T.



**Table 3**  
**Summary of Costs for BAT Option 1 at Conpak<sup>(1)</sup>**

Technology	Capital Cost	Annual Operating Cost
Lime addition/Settling/Filtration/pH Adjustment	\$ 116,500	Note 2
Nitrification-Denitrification	\$503,000	\$3,600 <sup>3</sup>
<b>Total</b>	<b>\$619,500</b>	
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Based on information from Refs. 7 and 8.</li> <li>2. Chemical requirements (lime and sulphuric acid) and disposal of the resulting sludge constitute the majority of operating costs, and cannot be accurately estimated without treatability study results.</li> <li>3. Includes: <ul style="list-style-type: none"> <li>• Oxygen</li> <li>• Electricity</li> <li>• Methanol</li> <li>• Sludge disposal</li> </ul> </li> </ol>		

Costs for the nitrification-denitrification system are based on information from Ref. 7 and include the following items:

- Fluidized bed reactors for nitrification and denitrification including oxygenator pits
- Clarifier with polymer addition system
- Mechanical equipment, pumps, piping and valves
- Installation and site work
- 35 percent installation
- 30 percent contingency allowance
- 15 percent engineering
- 7 percent G.S.T.

Treatment ponds for the settling system and nitrification-denitrification reactors would be situated outside. Therefore, additional cost for buildings would not need to be incurred.

## **4.2            BAT Option 3**

### **Description**

BAT Option 3 consists of the lime addition/settling/filtration/pH adjustment system described under BAT Option 1 in Section 4.1.

### **Performance**

The projected performance of implementing BAT Option 3 was summarized previously in Table 2 for the applicable technologies.

### **Costs**

Costs of the lime addition/settling/filtration/pH adjustment system were summarized previously in Table 3 for the applicable technologies.

## **4.3            BAT Option 4**

### **Description**

BAT Option 4 consists of BAT Option 1, along with the following measures:

- Management practices for the control of oil and grease and phenolics
- Maximum recycle of treated wastewater to process
- Treatment of residual effluent for dissolved solids using facilities proposed as BAT Options at ICI Cornwall.

Management practices for source control of oil and grease releases will include diligent collection of oils during equipment maintenance and repair, routine inspection of equipment for oil leaks, containment of higher risk leak and spill areas, placement of absorbent socks and pads around equipment, employee training on oil spill procedures, etc.

Recycle of treated wastewater for use in container washing will be limited by the build-up of dissolved solids, but it is reasonable to assume a recycle rate of 70 percent. The remaining 30 percent of flows, or approximately 10 m<sup>3</sup>/d, would be pumped to nearby ICI Cornwall for treatment. A pumping station, pipeline and appropriate fittings would be the only capital cost items.

## Performance

Since BAT Option 4 eliminates discharge at MISA Control Point BA0100, all contaminants are reduced by 100 percent.

## Costs

Costs for the implementation of BAT Option 4 are summarized in Table 4.

Table 4 Summary of Costs for BAT Option 4 at Conpak		
Technology	Capital Cost	Annual Operating Cost
Lime addition/ Settling/Filtration/pH Adjustment	\$116,500 <sup>3</sup>	Note 1
Nitrification/Denitrification	\$503,000 <sup>3</sup>	\$3,600 <sup>2</sup>
Best management practices for control of oil and grease	negligible	negligible
Maximum recycle of treated wastewater	negligible	negligible
Treatment at ICI Cornwall <ul style="list-style-type: none"><li>• Pumping station</li><li>• Piping and fittings</li></ul>	\$ 25,000 <sup>4</sup> Note 5	\$2,500 <sup>4</sup> \$ 0 <sup>4</sup>
Total	\$644,500 <sup>5</sup>	\$6,100 <sup>1</sup>
Notes:		
1. Chemical requirements (lime and sulphuric acid) and disposal of the resulting sludge constitute the majority of operating costs, and cannot be accurately estimated without treatability study results.		
2. Includes oxygen, electricity, methanol and sludge disposal.		
3. See Section 4.1 and Table 3.		
4. Developed based on Ref. 11.		
5. Distance to ICI unknown; a unit cost of \$160/m may be assumed for piping costs, which are not included in the total.		

Costs for implementing management practices for oil and grease control cannot be calculated in detail, since the necessary changes to the plant and employee training could not be defined within the scope of the study. It is reasonable to assume, however, that these costs would be relatively small for minor changes around the plant such as containment implementation. Negligible costs were also assumed for including oil control procedures in staff training programs, and other routine operating requirements.

The capital cost of the pumping and piping requirements for treated wastewater recycle will be negligible in comparison to the treatment system itself.

## 5.0

SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 5 presents a summary of estimated costs and projected performance of implementing BAT options at Conpak.

<p align="center"><b>Table 5</b> <b>Summary of Cost and Performance of BAT Options</b></p>				
Component	BAT Option 1	BAT Option 2	BAT Option 3	BAT Options 4 and 5
<b>Cost</b>				
Capital	\$619,500	\$0	\$116,500	\$644,500 <sup>2</sup>
Operating	\$ 3,600 <sup>1</sup>	\$0	Note 1	\$ 6,100 <sup>1</sup>
<b>Performance (Contaminant Loading Reduction kg/d)</b>				
TSS	2.9	0.0	2.9	3.2
Cadmium	<0.001	0.0	<0.001	0.001
Copper	0.025	0.0	0.025	0.027
Lead	0.024	0.0	0.024	0.029
Nickel	0.007	0.0	0.007	0.009
Zinc	0.006	0.0	0.006	0.007
Ammonia-nitrogen	1.50	0.0	Note 3	1.52
Nitrate-nitrogen	1.82	0.0	Note 3	1.84
Oil and Grease	0.0	0.0	0.0	0.099
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Chemical requirements and amount of sludge for disposal unknown and not included in operating cost.</li> <li>2. Piping requirements unknown and not included in capital cost.</li> <li>3. Not a targeted contaminant; incidental removal may occur.</li> </ol>				

## 6.0

REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report - Conpak, A Business Unit of ICI Canada Inc. April 25, 1991 (unpublished).
2. Development Document for Effluent Limitations, Guidelines and New Source Performance Standards for the Basic Fertilizer Chemicals Segment of the Fertilizer Manufacturing Point Source Category. U.S. EPA Report No. EPA-440/1-74-001-a. March 1974.
3. An Evaluation of Control Needs for the Nitrogen Fertilizer Industry. U.S. EPA Report No. EPA-6-79-186. August 1979.
4. Process Design Manual for Nitrogen Control. U.S. EPA Technology Transfer. October 1975.

5. Koon, J.H., Kaufmann, W.J. "Ammonia Removal from Wastewater by Ion Exchange", Journal of Water Pollution Control Federation, Vol. 47, pp. 448-465, 1975.
6. Telephone conversation with Irwin Higgins of Lake Industries Inc., Oakridge, Tennessee. July 1991.
7. General Technology Report Biological Nitrogen Removal.
8. Sister Plant Technology Report, Coagulation/Settling/Filtration Ponds at Cabot Canada Limited.
9. Inorganic Chemical Sector Plants Report on BAT Options-ICI Canada Inc. (Cornwall Works).
10. Treatability Manual, Volume III: Technologies for Control/Removal of Pollutants. EPA Report No. EPA-600/2-82-001c. September 1981.
11. General Technology Report Pumping Stations, Forcemains and Sewers.





## **APPENDIX**

### **Tables**



**Table A1, Stanchem, A Business Unit of ICI Inc., (Cornwall)**

Summary of Flows and Priority One Pollutants

MISA Control Point: BA0100

Description: Compac Effluent

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0.2	153	31.4	
COD	mg/L	10	140	75	1.37
Hydrogen Ion (pH)		1.4	12.9	7.14	
Ammonia Plus Ammonium	mg/L	2.2	200	53	1.52
Total Kjeldahl Nitrogen	mg/L	0.7	145	37	1.176
Nitrate and Nitrite	mg/L	0.156	1300	57	1.844
DOC	mg/L	4.4	1080	52	2.358
TOC	mg/L	4.4	940	57	2.528
Total Phosphorus	mg/L	0.02	86.5	6.6	0.252
Specific Conductance	uS/cm	460	24400	4900	
Total Suspended Solids	mg/L	4	580	83	3.2
Aluminum	ug/L	27	2040	382	0.014
Boron	ug/L	6	450	149	0.006
Cadmium	ug/L	3	24	24	0.001
Cobalt	ug/L	5	15	15	0.001
Chromium	ug/L	410	76	0.003	
Copper	ug/L	23	9200	684	0.027
Nickel	ug/L	20	2520	240	0.009
Lead	ug/L	75	5440	734	0.029
Strontium	ug/L	182	570	288	0.007
Thallium	ug/L	11	160	36	0.001
Zinc	ug/L	10	1290	188	0.007
Arsenic	ug/L	2	27.5	6.4	0
Antimony	ug/L	2	15	3	0
Selenium	ug/L	0.96	112	14.9	0.001
Mercury	ug/L	0.08	64	3.2	0
Phenolics (4AAP)	ug/L	2	38.6	10.4	0
Dibromochloromethane	ug/L	0.4	107	2.9	0
Chloroform	ug/L	0.4	1160	50	0.002
Carbon Tetrachloride	ug/L	0.3	125	2.8	0.001
Tetrachloroethylene	ug/L	0.4	8.9	2.56	0
Benzene	ug/L	0.68	2.7	1.69	0
Hexachlorobutadiene	ng/L	6.9	220	43	0
Hexachlorocyclopentadiene	ng/L	3.8	60	19	0
Hexachlorobenzene	ng/L	3	1440	410	0
Hexachloroethane	ng/L	42	5210	1670	0
Octachlorostyrene	ng/L	1.2	96	17.3	0
Pentachlorobenzene	ng/L	9	93	36	0
2,4,5-Trichlorotoluene	ng/L	1.4	83	41	0
1,2,3-Trichlorobenzene	ng/L	2.6	198	52	0

**Table A1, Stanchem, A Business Unit of ICI Inc., (Cornwall)**

Summary of Flows and Priority One Pollutants

MISA Control Point: BA0100

Description: Compac Effluent

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
1,2,3,4-Tetrachlorobenzene	ng/L	1.2	116	38.2	0
1,2,3,5-Tetrachlorobenzene	ng/L	2.1	33	10.3	0
1,2,4-Trichlorobenzene	ng/L	1.1	48	48	0
1,2,4,5-Tetrachlorobenzene	ng/L	1.1	44	20.6	0
Octachlorodibenzo-p-dioxin	pg/L	53	540	292	0
Octachlorodibenzofuran	pg/L	56	180	118	0
Oil and Grease	mg/L	0.9	15.4	2.88	0.099
Chloride, Unfiltered Reactive	mg/L	44	11200	1360	49.254
Fluoride, Unfiltered Reactive	mg/L	1.58	2.3	1.94	0.044
Sulphate, Unfiltered Reactive	mg/L	95	4560	986	35.664



**Table A2**  
**Toxicity Data for the First Six Months of the MISA Monitoring Regulation for**  
**Conpak, A Business Unit of ICI Canada Inc.**

Test Species	Number of Samples	Range of Data	Number of Non-lethal Samples
Trout	6	14% to non-lethal	1
<u>Daphnia magna</u>	5	11.5% to >100%	0

Comwall

Conpak Plant

		CONCENTRATIONS				LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	BA 0100	IN 0300	BA 0100	IN 0300
c	Total suspended solids	5	mg/L	83.4	4.9	3.2	0.154
c	Hydrogen ion (pH)			7.13	7.95		
c	Specific conductance		uS/cm	4900	229		
c	DOC	0.5	mg/L	52.1	3.8	2.36	0.119
c	TOC	5	mg/L	56.8		2.53	
c	Oil and grease	1	mg/L	2.88	0.9	0.099	0.028
c	Ammonia plus Ammonium	0.25	mg/L	49.5	0.15	1.41	0.005
c	Nitrate+Nitrite	0.25	mg/L	56.9	0.368	1.83	0.012
c	Total Kjeldahl nitrogen	0.5	mg/L	34.9	0.391	1.09	0.012
c	Total phosphorus	0.1	mg/L	6.63	0.038	0.252	0.001
09	Aluminum	30	ug/L	379	80.8	0.014	0.003
09	Beryllium	10	ug/L	5.82	12.2	—	—
09	Boron	50	ug/L	149		0.006	
09	Cadmium	2	ug/L	24	5	0.001	—
09	Chromium	20	ug/L	75.8	18	0.003	0.001
09	Copper	10	ug/L	679	16.9	0.027	0.001
09	Lead	30	ug/L	728	21.7	0.028	0.001
09	Molybdenum	20	ug/L	9.23	32	—	0.001
09	Nickel	20	ug/L	239	13.2	0.009	—
09	Strontium	20	ug/L	288		0.007	
09	Thallium	30	ug/L	36.2	33	0.001	0.001
09	Vanadium	30	ug/L	10.2	67	—	0.002
09	Zinc	10	ug/L	187	14.5	0.007	—
10	Antimony	5	ug/L	3.42	2	—	—
10	Arsenic	5	ug/L	6.15	3	—	—
10	Selenium	5	ug/L	13.8	2	—	—
11	Chromium (hexavalent)	10	ug/L	10.1		—	
12	Mercury	0.1	ug/L	3.15	0.354	—	—
14	Phenolics (4AAP)	2	ug/L	10.4	2.39	—	—
16	Carbon tetrachloride	1.3	ug/L	27.9	0.367	0.001	—
16	Chloroform	0.7	ug/L	49.4	7.81	0.002	—
16	Dibromochloromethane	1.1	ug/L	2.86	0.933	—	—
16	Tetrachloroethylene	1.1	ug/L	2.55	0.4	—	—
17	Benzene	0.5	ug/L	1.69	0.14	—	—
17	Toluene	0.5	ug/L	2.92	0.128	—	—
17	m-Xylene and p-Xylene	1.1	ug/L	1.71	0.204	—	—
17	o-Xylene	0.5	ug/L	0.865	0.292	—	—
19	Benzylbutylphthalate	0.6	ug/L	0.74		—	
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	10.7		—	
19	Di-n-butyl phthalate	3.8	ug/L	9.15		—	

ATG	PARAMETER	CONCENTRATIONS				LOADINGS kg/d	
		RMDL	UNIT	BA 0100	IN 0300	BA 0100	IN 0300
23	1,2,3,4-Tetrachlorobenzene	10	ng/L	37.5	10	—	—
23	1,2,3,5-Tetrachlorobenzene	10	ng/L	10.3	3	—	—
23	1,2,3-Trichlorobenzene	10	ng/L	52.1	11.3	—	—
23	1,2,4,5-Tetrachlorobenzene	10	ng/L	20.8	3	—	—
23	1,2,4-Trichlorobenzene	10	ng/L	47.4	3	—	—
23	2,4,5-Trichlorotoluene	10	ng/L	39.7	3	—	—
23	Hexachlorobenzene	10	ng/L	404	3	—	—
23	Hexachlorobutadiene	10	ng/L	42.5	5	—	—
23	Hexachlorocyclopentadiene	10	ng/L	18.6	17	—	—
23	Hexachloroethane	10	ng/L	1690	3.17	—	—
23	Octachlorostyrene	10	ng/L	17.2	6.92	—	—
23	Pentachlorobenzene	10	ng/L	35.3	4	—	—
24	Octachlorodibenzo-p-dioxin	30	pg/L	293	—	—	—
24	Octachlorodibenzofuran	30	pg/L	118	—	—	—
27	PCBT	0.1	ug/L	0.075	—	—	—
98	Ftflow		m3/d	31.4	—	—	—
11	Chloride	2	mg/L	1380	22.5	50.2	0.706
13	Sulphate	5	mg/L	982	26	35.5	0.817

Notes

BA0100 is the "Effluent from Conpak" which is discharged into the St. Lawrence River.



## **APPENDIX 6**

**Cyanamid Canada Inc., Niagara Falls**





**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
CYANAMID CANADA INC., NIAGARA FALLS**

**1.0            PLANT DESCRIPTION**

Cyanamid Canada Inc. in Niagara Falls, Ontario produces calcium carbide by reacting coke and lime in a furnace. Diamide lime is also manufactured on-site, by the drying and separation of wet diamide lime. Diamide lime, calcium carbide and fluorspar are milled and mixed to form desulphurization reagents. Calcium carbide and fluorspar are also reacted in an oven to produce calcium cyanamide, which is crushed, screened and stored for sale.

Raw water from the Niagara Falls hydro power canal is used at the plant for non-contact cooling of transformers and process equipment, and for regenerating an on-site water softener.

Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

**2.0            WASTEWATER SOURCES AND QUALITY**

**2.1            Wastewater Sources**

Process related effluents are not generated at the plant. Intake water pumped to on-site raw water ponds which also collect storm water, is used primarily for cooling equipment, although a small amount is softened and chlorinated for use in a closed loop cooling system. Cooling water is discharged back to the outlet of the cooling pond, to the South Fork Drain or directly to the Hydro power canal. Storm water runoff from the site is also discharged with cooling water. Table 1 presents the sources of discharges to each MISA Control Point included in the MISA Monitoring Regulation. The plant also monitored intake water prior to entrance to the raw water ponds at IN0400.

**2.2            Wastewater Flows and Quality**

Tables A1 to A4 in the Appendix present average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1", for the MISA Control Points CO0100, CO200, CO0500 and CO0600, respectively.

Flows monitored at Control Point CO0100 in the first few months of the monitoring period were split and monitored at CO0500 and CO0600 for the remainder of the period. At this time, monitoring at CO0100 was discontinued.

<p align="center"><b>Table 1</b>  <b>Sources of Discharges Monitored at MISA Control Points</b>  <b>at Cyanamid, Niagara</b></p>		
<b>MISA Control Point</b>	<b>Source</b>	<b>Flow (m<sup>3</sup>/d)</b>
CO0200	<ul style="list-style-type: none"> <li>• Cooling water from calcium cyanide plant.</li> <li>• Water softener regeneration effluent.</li> </ul>	16,330
CO0500 <sup>1</sup>	<ul style="list-style-type: none"> <li>• Cooling water from calcium carbide plant.</li> <li>• Storm runoff from calcium cyanamide process area.</li> <li>• Cooling water from desulphurization reagents process area.</li> </ul>	15,961
CO0600 <sup>1</sup>	<ul style="list-style-type: none"> <li>• Transformer cooling water from calcium cyanamide process area.</li> <li>• Storm water runoff from plant park lot</li> </ul>	938
<p>Note:</p> <p>1. CO0500 and CO0600 were monitored at CO0100 during the first few months of the MISA Monitoring Regulation period.</p>		

Table A5 present Priority 1 pollutants measured in raw water from the Hydro power canal.

### 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1**     -     A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2**     -     A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.

- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

### **BAT Option 1**

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Table A6. Five combined effluent samples from former Control Point CO0100, (currently MISA Control Points CO0500 and CO0600) were collected and tested on rainbow trout and Daphnia magna. Toxic concentrations ranged from >100 percent to non-lethal, with four non-lethal results for trout and three non-lethal results for Daphnia magna.

The toxicity results indicate that the effluents at CO0500 and CO0600 are essentially non-lethal, and thus, no change to the existing system is included in BAT Option 1. There is insufficient information to evaluate the cause of the three toxic results. Further testing to confirm toxicity, and if required, a toxicity reduction study, would be recommended to achieve non-lethality on a continuing basis.

Six tests using samples from Control Point CO0200 were also undertaken on the test species under the MISA monitoring program. Four samples were non-lethal to rainbow trout, and one sample was non-lethal to Daphnia magna, while the remaining samples had lethal concentrations of >100 percent. A review of the analytical data in Tables A1 and A2 shows that in general, effluents discharged at CO0200 had lower contaminant levels than those discharged through CO0100. Thus, the data does not indicate why there were more lethal results to Daphnia magna from tests using CO0200 effluents. Because lethal concentrations were greater than 100 percent, the effluents are considered to be essentially non-lethal, and no changes to the system are recommended under BAT Option 1. However, further testing to confirm non-lethality, and if required, a toxicity reduction study, are recommended to achieve non-lethality on a continuing basis.

## **BAT Option 2**

Under 40 CFR Part A15 of the U.S. Federal Register (July 1, 1989 Edition), Subpart C - Calcium Carbide Production Subcategory, BAT was defined as "no discharge of process wastewater pollutants to navigable waters". Non-contact cooling water and storm water were not included in the definition of process wastewater. At the Cyanamid plant, process wastewaters are not discharged, and the existing process meets U.S. BAT.

BAT was not defined in the U.S. for the production of desulphurization reagents, calcium cyanamide or calcium cyanide. Furthermore, "sister" plants, with similar production lines, were not identified in the U.S. or elsewhere.

## **BAT Option 3**

Cyanamid, Niagara Falls is the only plant in the Province producing calcium carbide, calcium cyanamide, desulphurization reagents and calcium cyanide. Thus, BAT Option 3 is defined as the existing system at Cyanamid.

## **BAT Option 4**

Careful review of the process and the quality of discharges from the plant reveal that most contaminants are not likely generated through site operations, but are those that are present in raw water. Levels of ammonia, TKN, nitrate, DOC, TSS, aluminum, strontium, zinc, sulphide, oil and grease, chloride and sulphate measured at Control Points CO0100, CO0200, CO0500 and CO0600 fall within the range of typical raw water quality in Ontario and are not significantly different than those measured in the intake water.

Technologies for the removal of low levels of contaminants present in Cyanamid effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

Cyanide detected in samples from all four effluent monitoring points at mean concentrations ranging from 0.02 to 0.09 mg/L is a process related contaminant. Pollutant prevention by controlling contamination at the source is the most desirable approach to reducing cyanide levels in plant effluents.

Within the scope of this study, the source of cyanide was not identified. Sources could include storm water runoff as a result of contact with products or fugitive emissions, or



contamination of pond water as a result of soil contamination and the absence of impermeable pond linings. An audit of the source of cyanide is necessary for the identification of appropriate control methods. These may include process changes, best management practices for storm water control, and in the case of soil contamination, lining of intake water ponds or implementation an alternative intake water distribution system which avoids the use of ponds altogether. The general technology report outlines design considerations and costs for pond linings (Ref. 2).

Until an audit of the cyanide source has been undertaken, a BAT Option 4 incorporating technologies that achieve maximum reduction of this contaminant cannot be defined. Cyanide removal is theoretically possible, in a two stage alkaline chlorination process. However, the global search did not identify any applications of this technology for treating wastewaters containing the dilute levels experienced at Cyanamid. Furthermore, negative impacts are associated with chlorination including:

- The potential for formation of halogenated organic compounds by the reaction of chlorine with organic precursors in raw water.
- The toxicity of free chlorine. Thus, dechlorination of effluents would also be required.

The applicability and effectiveness of chlorination, followed by dechlorination for cyanide removal could be considered if feasible pollution prevention solutions are not identified.

Phenolics were detected a low levels ( $<2 \mu\text{g/L}$ ) in samples taken at Control Points CO0500 and CO0600. Knowledge of the process suggests that phenol contamination is not contributed from cooling water operations, and therefore, is likely contributed in storm water runoff discharging through these Control Points. General usage materials at the plant, including diesel oil or gasoline, may be the source of storm water contamination. In-plant management practices for storm water control are recommended for reducing or eliminating phenols in effluents.

### **BAT Option 5**

Technologies that would advance the plant further toward zero-discharge were not identified in the global search. Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool power generating equipment such as transformers, as well as process equipment in all manufacturing sectors. Other cooling methods, such closed-loops air cooled systems, would require very large capital expenditures and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Furthermore, opportunities for consumption of cooling tower blowdown or condensate do not exist in the production of any of the "dry" products produced at Cyanamid, Niagara Falls. Therefore, BAT

Option 5 is the same as BAT Option 4, since technologies that further the plant toward zero discharge of effluents were not identified.

### Summary

Table 2 presents a summary of BAT Options recommended for the plant.

Table 2 Summary of BAT Options for Cyanamid, Niagara Falls		
BAT Option	Definition	Description
1	Least cost producing non-lethal effluents	No change to existing system.
2	U.S. BAT	No U.S. BAT defined.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum pollutant reduction	Not defined <sup>1</sup> .
5	Furthest toward zero discharge of pollutants	Same as BAT Option 4.
Note:		
1. A BAT Option 4 cannot be defined until the source of cyanide is identified through an audit.		

## 5.0 REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report - Cyanamid Canada Inc., Niagara Falls. March 26, 1991 (unpublished).
2. General Technology Report - Pond Linings.

## **APPENDIX**

### **Tables**



**Table A1, Cyanamid Canada Inc. (Niagara Plant)****Summary of Flow and Priority One Pollutants****MISA Control Point: CO0100****Description: Whitty Creek**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	3050	131000	18100	
Cyanide Total	mg/L	0.002	0.002	0.095	1.775
Hydrogen Ion (pH)		7.85	8.82	8.48	
Ammonia Plus Ammonium	mg/L	0.3	0.61	0.62	10.23
Total Kjeldahl Nitrogen	mg/L	0.38	1.2	0.99	16.283
Nitrate and Nitrite	mg/L	0.38	1.2	0.7	13.678
DOC	mg/L	1.2	15	4.1	77.992
Total Suspended Solids	mg/L	4.2	190	15	266.182
Aluminum	ug/L	190	440	278	4.619
Strontium	ug/L	150	190	172	2.901
Zinc	ug/L	11	42	21	0.345
Oil and Grease	mg/L	0.96	2.8	1.28	25.365



**Table A2, Cyanamid Canada Inc. (Niagara Plant)****Summary of Flow and Priority One Pollutants****MISA Control Point: CO0200****Description: Hydro Creek**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	15000	30000	22800	
COD	mg/L	10	17	13.5	233.399
Cyanide Total	mg/L	0.001	0.86	0.017	0.3
Total Kjeldahl Nitrogen	mg/L	0.16	1.4	0.67	11.718
Nitrate and Nitrite	mg/L	0.16	2.3	0.59	10.093
DOC	mg/L	0.32	2.3	3.28	58.444
Specific Conductance	uS/cm	251	345	277	
Total Suspended Solids	mg/L	3.2	73.6	13.04	251.824
Aluminum	ug/L	588	560	232	4.006
Strontium	ug/L	130	160	146	2.555
Zinc	ug/L	3	70	17	0.316
Sulphide	ug/L	30	50	40	0.691
Oil and Grease	mg/L	0.5	2.4	1.1	19.984
Chloride, Unfiltered Reactive	mg/L	15	22	18.5	319.517
Sulphate, Unfiltered Reactive	mg/L	21	29	25	431.809

**Table A3, Cyanamid Canada Inc. (Niagara Plant)****Summary of Flow and Priority One Pollutants****MISA Control Point: CO0500****Description: Cooling Pond**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	2690	22700	16000	
Cyanide Total	mg/L	0.005	0.153	0.029	0.0483
Hydrogen Ion (pH)		8.08	8.79	8.44	
Ammonia Plus Ammonium	mg/L	0.04		0.49	8.937
Total Kjeldahl Nitrogen	mg/L			1.1	19.789
Nitrate and Nitrite	mg/L	0.025	1.3	0.664	11.125
DOC	mg/L	0.32	5	2.34	39.939
Specific Conductance	uS/cm	262	447	302	
Total Suspended Solids	mg/L	3.2	2200	35.54	663.733
Aluminum	ug/L	110	370	201	3.721
Strontium	ug/L	140	160	147	2.665
Phenolics (4AAP)	ug/L	1	5	2	0.038

**Table A4, Cyanamid Canada Inc. (Niagara Plant)****Summary of Flows and Priority One Pollutants****MISA Control Point: CO0600****Description: South Fork**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	674	1210	790	
Cyanide Total	mg/L	0.008	0.331	0.097	0.092
Hydrogen Ion (pH)		8.29	8.91	8.65	
Ammonia Plus Ammonium	mg/L	0.1	0.82	0.38	0.329
Total Kjeldahl Nitrogen	mg/L	0.72	2.8	1.5	1.095
Nitrate and Nitrite	mg/L	0.025	69	3.744	3.58
DOC	mg/L	0.7	2.9	2.95	2.736
TOC	mg/L	1.2	7.7	3.9	3.825
Specific Conductance	uS/cm	380	589	440	
Total Suspended Solids	mg/L	3.2	220	23	22.704
Aluminum	ug/L	58	440	166	0.152
Strontium	ug/L	150	180	169	0.139
Zinc	ug/L	2	180	52	0.048
Phenolics (4AAP)	ug/L	1	3	2	0.002
Oil and Grease	mg/L	0.5	5.3	1.34	1.251

**Table A5, Cyanamid Canada Inc. (Niagara Plant)****Summary of Flow and Priority One Pollutants****MISA Control Point: IN0400****Description: Intake**

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
COD	mg/L	17	24	20.5
Total Kjeldahl Nitrogen	mg/L	0.16	1.1	0.45
Nitrate and Nitrite	mg/L	0.23	1.3	0.48
DOC	mg/L	0.32	25	3.09
Specific Conductance	uS/cm	270	310	289
Total Suspended Solids	mg/L	30	34	40
Aluminum	ug/L	66	340	151
Strontium	ug/L	130	160	144
Zinc	ug/L	2	60	17.6
Sulphide	ug/L	20	40	30
Oil and Grease	mg/L	0.5	25	1.7
Chloride, Unfiltered Reactive	mg/L	15	15	15
Sulphate, Unfiltered Reactive	mg/L	20	27	23.5

**Table A6**  
**Toxicity Data for Cyanamid Canada Inc., Niagara Falls for the First Six Months**  
**of MISA Monitoring Regulation**

Control Point	Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
CO0100	Rainbow trout	5	>100% to non-lethal	4
	Daphnia magna	5	>100% to non-lethal	3
CO0200	Rainbow trout	6	>100% to non-lethal	4
	Daphnia magna	6	>100% to non-lethal	1



**Cyanamid Canada  
Niagara Falls  
(Niagara Plant)**

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS						LOADINGS (kg/d)					
				CO 0100	CO 0200	CO 0500	CO 0600	IN 0400		CO 0100	CO 0200	CO 0500	CO 0600	IN 0400	
c	Total suspended solids	5	mg/L	14.6	11.6	38.7	19.7	29.3		266	215	268	18.9	1060	
c	Hydrogen Ion (pH)			8.49	8.32	8.44	8.65	8.19							
c	Specific conductance		uS/cm	350	273	296	432	289							
c	DOC	0.5	mg/L	4.15	3.27	2.36	2.87	3.09		78	58.3	39.6	2.62	112	
c	TOC	5	mg/L	3.97	2.98	3.33	4.01	2.74		71	52.2	57.8	3.88	98.9	
c	Oil and grease	1	mg/L	1.28	1.48	1.01	1.39	1.75		25.4	25.3	17.6	1.21	63.2	
c	Ammonia plus Ammonium	0.25	mg/L	0.618	0.223	0.49	0.38	0.078		10.2	3.84	6.95	0.368	2.82	
c	Nitrate+Nitrite	0.25	mg/L	0.89	0.587	0.658	3.57	0.478		13.7	10.1	10.7	0.355	17.3	
c	Total Kjeldahl nitrogen	0.5	mg/L	0.986	0.667	1.13	1.25	0.45		16.3	11.7	16.8	1.18	16.2	
c	Total phosphorus	0.1	mg/L	0.049	0.028	0.018	0.025	0.035		0.821	0.449	0.277	0.021	1.26	
09	Aluminum	30	ug/L	278	232	201	166	151		4.62	4.01	3.05	0.164	5450	
09	Strontium	20	ug/L	172	146	147	169	144		2.9	2.55	2.55	0.141	5200	
09	Zinc	10	ug/L	20.4	17.3	22.1	51.9	17.6		0.344	0.315	0.15	0.055	635	
14	Phenolics (4AAP)	2	ug/L	1.4	1.5	2	2	1.64		0.024	0.026	0.026	0.002	59.2	
15	Sulphide	20	ug/L	20	40	40	40	30		0.364	0.691	0.843	0.036	1080	
2	Cyanide Total	0.005	mg/L	0.095	0.017	0.025	0.09	0.001		1.78	0.288	0.295	0.085	0.0361	
98	Flow, Average		m3/d	18100	17700	17800	924								
11	Chloride	2	mg/L	30	18.5	16	31	15		546	320	337	28.1	542	
12	Fluoride	0.1	mg/L	0.2	0.1	0.1	0.1	0.1		3.64	1.73	2.11	0.1	0.2	
13	Sulphate	5	mg/L	33	25	21	30	23.5		600	432	443	27.2	848	

Notes:

Intake loadings have been calculated using the CO0200 flow average and half the sum of the other effluent stream flows.

CO0100 is the "Final Effluent to Whitty Creek"; discontinued from May/'90.

CO0200 is the "Effluent to the Hydro Canal".

CO0500 and CO0600 are the "Cooling Pond Overflow" and the "South Fork Effluent" 0500 and 0600 together replaced 0100 as monitoring points.

All discharges flow to Lake Ontario via local watercourses.



## **APPENDIX 7**

**Cyanamid Canada Inc., Welland**



**INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
CYANAMID CANADA INC. (WELLAND)**

**1.0      PLANT DESCRIPTION**

Cyanamid Canada Inc., Welland produces a number of products including:

- Dicyandiamide (DICY)
- 50 percent cyanamide solutions
- Phosphine
- Phosphine derivatives
- Electronic grade chemicals

By-products including high purity phosphoric acid, diamide lime slurry and a DICY Mother Liquor Slurry are also produced and sold. A portion (30 percent) of diamide lime slurry is precipitate in an onsite sludge pond.

Approximately 22,500 m<sup>3</sup>/d of intake water from the Welland River is used as cooling water and process water. City water, softened using zeolite, is used for boiler water make-up.

Details on the plant, the water treatment facility and wastewater generation are presented in the site visit report (Ref. 1).

**2.0      WASTEWATER SOURCES AND QUALITY**

**2.1      Sources**

The sources of wastewater from the process areas are summarized in Table 1.

Wastewater, including condenser condensate and effluent from an onsite sludge pond, is discharged directly via MISA Control Point CO0400 to Miller's Creek, which runs through the Cyanamid property.

All storm water from the northern portion of the facility flows to Miller's Creek, including flows from the dicyandiamide and phosphine production areas and from 87 hectares of decommissioned sludge ponds. These flows combine with process wastewater prior to discharge at Control Point CO0200.



**Table 1**  
**Wastewaters Produced in Process Areas**

Source	Type	Flow (m <sup>3</sup> /d)	Destination
<b>Steam Plant</b>			
Softener Effluent	Regeneration effluent	variable	Miller's Creek (CO0200)
Boiler blowdown	Boiler blowdown	28.8	Miller's Creek (CO0200)
<b>Dicyandiamide/ AC-50 Process Areas</b>			
Barometric condensers	Condensate	5,760 to 8,064	Miller's Creek (CO0200)
Condenser and process equipment cooling	Once through non-contact cooling water	2,764	Miller's Creek (OT1300)
Diamide lime slurry (filter press back-wash)	Process effluent	979	Sludge pond
Sludge pond effluent	Pond effluent	7,945	Miller's Creek (CO0400)
<b>Phosphine Plant and Phosphine Derivatives</b>			
Scrubber liquor	Process effluent called "phossey" water.	52	Sludge pond
Line and vessel wash water	Process water	9 m <sup>3</sup> /batch	Sludge pond
Condenser and process equipment cooling	Once through non-contact cooling water	3,600	Miller's Creek (CO0200)
Condenser condensate, evaporator condensate and wastewater from seal pots, melt tank, gas holders and blowers.	Process water	360	Sludge pond or recycled.
<b>Laboratory</b>			
Wastewater from glassware washes	Process water	insignificant	Welland River
<b>Sanitary Treatment Facilities</b>			
Phosphine process building Aeroflow Aerobic System <sup>TM</sup>	Sanitary treatment plant effluent	3.8	Miller's Creek (CO0200)
Phosphine maintenance building Aeroflow Aerobic System <sup>TM</sup>	Sanitary treatment plant effluent	1.9	Miller's Creek (CO0200)

Storm water from the southern portion of the plant, which is no longer in use, and wash water produced in the laboratory from the washing of glassware are discharged directly to the Welland River.

There is no end-of-pipe treatment at Cyanamid. However, the bed of Miller's Creek has been altered to allow equalization of wastewater to prevent sudden fluctuations in pH and specific conductance values.

A description of the MISA Control Points is presented in Table 2. Effluents monitored at Control Points ST0500 to ST1200 discharge to the Welland River, while those monitored at Control Points CO0200, CO0400 and OT1300 discharge to Miller's Creek.

**Table 2**  
**MISA Control Points at Cyanamid Canada (Welland)**

MISA Control Number	Location/Source	Flow (m <sup>3</sup> /d) <sup>1</sup>
CO0200	Miller's Creek (final effluent)	28,700
CO0400	Sludge Pond #11 effluent	7,945
ST0500	River pump house runoff	2,124
ST0600	1st Ave. Sewer (surface ditch)	1,052
ST0700	1st Ave. Sewer (inground)	423
ST0800	3rd Ave. Sewer	125
ST0900	4th Ave. Sewer	115
ST1000	5th Ave. Sewer (west of gate)	370
ST1100	5th Ave. Sewer (east of gate)	389
ST1200	Lab sewer	157
OT1300	Dicyandiamide unit once through cooling water	2,767

Notes:

1. Average flow from 12 months of MISA Monitoring Regulation data.

## 2.2 Wastewater Flows and Quality

Appendix Tables A1, A2 and A3 present the average, maximum, and minimum flow and concentration data as well as average daily loadings for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Points CO02-00, CO0400 and OT01300, at Cyanamid Canada Inc. (Welland Plant).

### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed in the following discussion.

#### 3.1 BAT Option 1

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Appendix Table A4, for Control Points CO0200 and OT1300. Control Point CO0400 was not tested for toxicity and will not be directly addressed under this Option.

#### Once Through Cooling Water (OT1300)

At Control Point OT1300, two samples were tested using rainbow trout. The lethal concentrations of both of these samples were greater than 100 percent. The one OT1300 sample tested with Daphnia magna was non-lethal.

---

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

From these results, it may be concluded that the OT1300 effluent is essentially non-lethal. BAT Option 1 does not include recommendations for the reduction of toxicity at OT1300.

### **Final Effluent (CO0200)**

When rainbow trout was used as the test species, the lethal concentrations of the CO0200 samples ranged from 80.7 percent to non-lethal, with three non-lethal samples. The lethal concentration of CO0200 samples tested with Daphnia magna ranged from 20.8 percent to 40.6 percent.

Several possible sources of toxicity at Control Point CO0200 are evident in Table A1. However, the most obvious potential sources include pH, ammonia and aluminum.

Aluminum was measured in final effluents at a mean concentration of 789 µg/L. Aluminum toxicity to rainbow trout and Daphnia magna using 48 h and 96 h testing as prescribed under the MISA program was not identified in the literature. However, these test were also carried out in effluent samples from another Inorganic Chemical Sector plant, Norton Advanced Ceramics of Canada Ltd. (Ref. 13), with similar average aluminum levels. Samples of streams with mean aluminum concentrations of 748 µg/L and 1,140 µg/L at this plant yielded essentially non-lethal results. These results indicate that aluminum at levels in Cyanamid's final effluent stream is not a likely cause of the lethal results reported.

Excursions in pH outside of the range of 6.5 to 8.5 may have lethal effects in themselves. In addition, high pH may contribute to the toxicity of ammonia by increasing the un-ionized fraction present, as demonstrated in the worst-case scenarios presented in Table 3, where un-ionized ammonia levels at CO0200 and CO0400 are recorded. Total ammonia concentrations are significantly higher than the 48 hour LC50 concentration 0.66 mg/L reported for Daphnia magna at 22 °C and 30 °C<sup>2</sup> (Ref. 10). Levels of un-ionized ammonia are also substantially higher than lethal concentrations of 0.63 mg/L (Ref. 11) and Ontario surface water quality objectives of 0.02 mg/L (Ref. 12).

Reduction of ammonia levels and control of pH must be considered for both Control Points CO0200 and CO0400 to produce non-lethal effluents on an on-going basis.

The level of ammonia nitrogen at CO0200 is likely the result of loading from two sources; the sludge pond effluent, and the barometric condenser condensate. The plant also reports that a significant portion of ammonia and nitrate loadings are contributed to the final effluent from groundwater contaminant. Information on this source of

---

2

No pH values were reported.



loadings was unavailable at the time of report writing, and was therefore, not incorporated into assumptions made for development of BAT Option recommendations.

**Table 3**  
**Levels of Un-ionized Ammonia at Control Points CO0200 and CO0400**

Control Point	Mean Total Ammonia Concentration (mg/L)	Fraction of Un-ionized Ammonia <sup>1</sup>	Un-ionized Ammonia Concentration (mg/L)
CO0200	7.9	0.22192	1.8
CO0400	15.9	0.41739	6.6
Notes:			
1. Based on maximum pH at each Control Point, a temperature of 25°C, and information provided by the MOE Hamilton Regional Office.			

Under the current discharge scheme, sludge pond effluent (MISA Control Point CO0400) combines with barometric condenser condensate and a number of other effluents, as documented in Table 1, prior to final effluent discharge at MISA Control Point CO0200. Because the final effluent stream does not require treatment for nitrogen removal, BAT Option 1 also includes a recommendation to divert the barometric condenser condensate to the sludge pond, instead of treating the entire effluent stream at CO0200. This diversion captures two major sources of ammonia (sludge pond effluent and barometric condenser condensate) in one stream and results in more effective ammonia control. This diversion will approximately double the flow rate to the pond, but will not adversely affect settling performance since the surface hydraulic loading rates will remain low.

Throughout the remainder of this report, this combined stream resulting from diversion of the condensate to the sludge pond will be referred to as the condensate/sludge pond effluent. Based on company estimates of condensate flow rate and flow rates at CO0400, the total flow rate of the condensate/sludge pond effluent will be approximately 14,900 m<sup>3</sup>/d. If all loadings of ammonia nitrogen at CO0200 stem from these two sources, the average concentration of ammonia in the condensate/sludge pond effluent will be 14.2 mg/L. This level is comparable to that already in the sludge pond (CO0400 mean ammonia concentration is 15.9 mg/L) and will not result in substantial atmospheric losses. Small losses of ammonia to the atmosphere are readily assimilated by the environment since ammonia is a natural constituent of the nitrogen cycle.

Ammonia is present in the condensate/sludge pond effluent at levels which are treatable by conventional industrial wastewater treatment technologies such as air stripping, ion exchange, breakpoint chlorination or nitrification.



Biological nitrogen removal through nitrification-denitrification has several advantages over other technologies in the treatment of the condensate/sludge pond effluent, including:

- Removal of both ammonia and nitrate nitrogen with minimal formation of undesirable by-products.
- Relatively small amount of inter-media contaminant transfer.
- Possible incidental removal of total cyanide, depending on the form of cyanide.

Thus, BAT Option 1 includes the use of nitrification-denitrification for the control of ammonia and nitrate nitrogen levels in the condensate/sludge pond effluent. This technology is described in greater detail in a General Technology Report (Ref. 2).

The fluctuations in pH at CO0200 should be controlled by an automated pH adjustment system situated in a mix tank which will allow for adequate mixing. It should be noted that following nitrification-denitrification, the condensate/sludge pond effluent will be in a neutral pH range, as required by the treatment process. However, final effluent at CO0200 may require further pH adjustment and this control measure is recommended as part of BAT Option 1.

Some uncertain sources of toxicity remain. Process-related contaminants such as cyanamide contribute to relatively high TKN levels. However, no data on aqueous toxicity of these compounds were available at the time of report preparation. Thus, these compounds cannot be discounted as possible sources of toxicity and examination of the aquatic toxicities for cyanamide, dicyandiamide and related process contaminants should be included in a Toxicity Reduction Study.

Therefore, BAT Option 1 entails:

- Diversion of barometric condenser condensate to the sludge pond.
- Nitrification/denitrification of the condensate/sludge pond effluent.
- Final effluent pH control at CO0200.
- A Toxicity Reduction Study for cyanamide derivatives.

These options will be discussed in more detail in Section 4.0.

### **3.2            BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), BAT for cyanamide or phosphine producing facilities was not defined. Furthermore, "sister" plants with similar production lines were not identified in the U.S. or elsewhere in an exhaustive global search. Therefore, BAT Option 2 was not defined for Cyanamid (Welland).

### **3.3            BAT Option 3**

Cyanamid (Welland) is the only plant in the Province producing dicyandiamide, cyanamide solutions, phosphine and phosphine derivatives. Thus, BAT Option 3 is defined as the existing system at Cyanamid.

### **3.4            BAT Option 4**

BAT Option 4 is intended to provide maximum overall water pollution control.

#### **3.4.1            Once Through Cooling Water (OT1300)**

Once through non-contact cooling water uses are not a likely source of the "Priority 1" parameters noted in Table A3 for OT1300. The majority of the "Priority 1" contaminants in this stream including total suspended solids are not associated with the raw materials or the products at the plant and are most likely originating in the intake water.

The level of total suspended solids in OT1300 (34 mg/L) suggests that treatment could be considered to reduce the levels to 5.0 mg/L, using a coagulation, settling and filtration pond system similar to that in use at Cabot Canada Limited (Ref. 3). However, implementation of a coagulation/settling/filtration system will produce related problems which must be addressed, including:

- The impacts of wastewater treatment chemicals on effluents, in terms of contaminant concentrations and toxicity.
- The handling and disposal of wastewater treatment residuals.
- The dependence of removal performance on system reliability and operator training.

Because of these problems, the relatively low levels of TSS in the effluent, and the fact that TSS probably originates in the intake water, technologies to reduce TSS are not recommended in BAT Option 4 for treatment of once through cooling water.

#### **3.4.2            Sludge Pond and Final Effluent (CO0400 and CO0200)**

Since CO0400 is upstream of CO0200, many of the "Priority 1" pollutants identified are common to both Control Points.

The levels of strontium, zinc, arsenic antimony, chloride, fluoride, and sulphate measured at Control Points CO0200 and CO0400 fall within the range of typical raw water quality in Ontario, and are not likely a result of plant operations. Technologies for the removal of these low levels of contaminants may be available and have been used in specific applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Reduction of loadings of these contaminant will not be considered under BAT Option 4.

### **Oil and Grease and Phenolics**

Oil and grease levels at CO0200 (2.58 mg/L) and at CO0400 (1.5 mg/L), while comparable, suggest that there are sources downstream of CO0400 possibly including storm water, condenser condensate and once through cooling water. Management practices could be exercised at the plant site to reduce contamination of both process and storm water.

The phenolics levels at both Control Points could likely be reduced by similar management practices since phenolics are probably associated with oil and grease in the effluents. These pollution prevention activities are discussed in more detail in Section 4.0.

### **Aluminum and TSS**

Both total suspended solids (TSS), and aluminum are at treatable levels at Control Points CO0200 and CO0400. Both of these contaminants could originate from the process, specifically from the diamide lime slurry which is comprised of calcium carbonate, graphite, alumina and calcium cyanamide. The fact that the loading at Control Point CO0200 is more than twice the loading at CO0400 however, suggests that there are other significant sources of suspended solids and aluminum that should be investigated.

However, suspended solids, aluminum or aluminum compounds are not likely present at significant levels in the barometric condenser condensate, because these would not be volatilized in the process. Therefore, other possible sources of TSS and aluminum need to be considered, including:

- Raw water
- Boiler water treatment residuals and blowdown
- Phosphine plant once through cooling water
- Sanitary treatment plant effluents
- Stormwater.

Aluminum and TSS levels in raw water measured at the intake to Cyanamid were reported at mean levels of 1,970  $\mu\text{g/L}$  and 55  $\text{mg/L}$  respectively for the Welland River. These levels are higher than those reported in effluents measured at CO0200, indicating no net contribution from the plant discharges.

Because BAT Option 4 addresses the maximum reduction of pollutants discharged, independent of their source, methods for reducing levels of TSS and aluminum were considered.

Generally, coagulation, settling and filtration can be used to reduce TSS to 5  $\text{mg/L}$  (Ref. 3) and also reduce insoluble aluminum precipitates. In the sludge pond, chemical precipitation of the phosphorus and settling is already taking place. Filtration should be considered to further reduce TSS and aluminum levels from this source. This filtration system option will be discussed in more detail in Section 4.0.

### **Phosphorus**

Phosphorus is present at both Control Points and half of the loading originates from the sludge pond effluent. Filtration of the condensate/sludge pond effluent should reduce loadings of phosphorus in insoluble forms to Control Point CO0200.

### **Other Contaminants**

Many process related contaminants, including cyanide, ammonia-nitrogen, total kjeldahl nitrogen (TKN), and nitrate nitrogen were detected at both Control Points. Analysis of the data presented in Appendix Tables A1 and A2 reveals that more than half of the loading of each of these contaminants originates from sources other than the sludge pond effluent. One source of these contaminants is the barometric condenser condensate since this is the only process-related effluent discharged downstream of the sludge pond effluent. Thus, it has been assumed that the majority of these process related contaminants at CO0200 are contributed by either the sludge pond effluent (CO0400) or the barometric condenser condensate. The plant reports that contaminated ground water is also a source of contaminants discharged in final effluents. Information quantifying this contamination was unavailable at the time of report preparation.

End-of-pipe treatment is generally most effective, both in performance and cost, on more concentrated streams. In the case of Cyanamid (Welland), more effective treatment could be realized if the barometric condenser condensate was re-directed to the sludge ponds. This will approximately double the flow rate to the pond, based on reported flows rates from the MISA monitoring period, but will not adversely affect settling performance since the surface hydraulic loading rate remains low. This condensate/sludge pond effluent will then be subjected to further treatment as documented below.



In order to identify treatment and/or control options for the condensate/sludge pond effluent stream, the concentrations of cyanide, TKN, ammonia and nitrate were estimated. The loadings at the final effluent (CO0200) were assumed to be from either sludge pond effluent or condenser condensate. These loadings, divided by the total flow rate of the condensate/sludge pond effluent (approximately 14,900 m<sup>3</sup>/d as recorded under BAT Option 1) are summarized in Table 4.

<b>Table 4</b> <b>Estimated Concentrations of Some Major Contaminants in the Proposed</b> <b>Condensate/Sludge Pond Effluent at Cyanamid (Welland)</b>		
<b>Contaminant</b>	<b>Total Loading<sup>1</sup> (kg/d)</b>	<b>Estimated Concentration<sup>2</sup> (mg/L)</b>
Total Cyanide	2336	0.157
Total Kjeldahl Nitrogen	747.6	50.2
Ammonia plus Ammonium Nitrogen	211.8	14.2
Nitrate plus Nitrite Nitrogen	249.0	16.7
<b>Notes:</b>  1. Loadings of the noted contaminants in the final effluent (CO0200) are assumed to stem from either the barometric condenser condensate or the sludge pond effluent. 2. Estimated flow rate of condensate/sludge pond effluent stream is 14,900 m <sup>3</sup> /d.		

Levels of TKN in the effluent most likely reflect the presence of dicyandiamide, cyanamide and related compounds. It is unknown whether these compounds will decay to produce ammonia under natural conditions. Indeed, an exhaustive global search did not reveal technology for the hydrolysis of similar dicyandiamide related waste streams. Thus, treatment technologies for the reduction of TKN will not be considered under BAT Option 4.

Levels of ammonia and nitrate-nitrogen can be controlled through the use of nitrification-denitrification as described under BAT Option 1.

Methods for cyanide reduction include natural degradation, oxidation, evaporation, ion exchange, reverse osmosis, copper-catalyst activated-carbon absorption and thermal hydrolysis (Ref. 4 and 5). Examination of these methods suggests that oxidation is the most practical method of reducing cyanide loadings at the levels found in Cyanamid's effluents. Because the cyanide most likely originates from the sludge pond effluent and the barometric compressor condensate, it is recommended that BAT Option 4 include oxidation of cyanide in the condensate/sludge pond effluent.

Removal of cyanide by chemical oxidation is practised in a number of industrial sectors including:

- Inorganic chemical manufacturing.
- Metal finishing.



- Textile mills.

Several methods of oxidizing cyanide to nitrogen gas and bicarbonate are available including alkaline chlorination, ozonation with copper catalyst, ozonation with ultraviolet light, hydrogen peroxide and formaldehyde addition at an elevated temperature, and addition of potassium permanganate. Of these treatments, alkaline chlorination is the most widely used method of cyanide removal (Ref. 4 and 5) and is recommended under BAT Option 4. Dechlorination of effluents is also required.

### Sulphide

Sulphide was detected at 37 µg/L in the sludge pond effluent (CO0400). Since oxidation of cyanide has been recommended as part of BAT Option 4, removal of sulphides will occur concurrently with cyanide oxidation.

### Toluene

Toluene was detected in the sludge pond effluent at 2.1 µg/L. The toluene levels will likely be eliminated when the sludge pond effluent is treated using nitrification/denitrification processes.

### pH

As under BAT Option 1, final effluent pH control is recommended for Control Point CO0200. The condensate/sludge pond effluent will be at a pH of 8 to 8.5 following alkaline chlorination/dechlorination. Final effluent pH adjustment will ensure a pH in the range 6.5 to 8.5.

## **3.4.3      Summary**

In summary, BAT Option 4 entails:

- No changes to the existing once through cooling water discharge (OT1300).
- Storm Water Control Study for aluminum and TSS loadings in CO0200 not contributed by CO0400.
- Discharging DICY barometric condenser condensate to the sludge pond for further treatment with sludge pond effluent (CO0400) for:
  - Removal of ammonia by nitrification.

- Removal of nitrates and toluene by denitrification.
- Removal of cyanide and sulphides by alkaline chlorination, followed by dechlorination of effluents.
- Reduction of TSS, aluminum, and phosphate by gravity sand filtration.
- Final effluent pH adjustment at CO0200.
- Management practices for oil and grease and phenolics control.

### 3.5 BAT Option 5

Technologies that would advance this plant further toward zero-discharge of wastewater were not identified in the global search. There are no opportunities for consumption of boiler blowdown, barometric condenser condensate, softener regeneration effluent, line and vessel wash water, and once through cooling water in the process. Although approximately 70 percent of the diamide lime is sold to produce desulphurization reagents (Ref. 6), the remainder is precipitated in the sludge pond. It may be possible to consider utilizing the treated sludge pond effluent (as proposed in the previous section) as once through cooling water to replace Welland River water. Although this would result in a 6,364 m<sup>3</sup> reduction in daily water requirements, and will further the plant towards zero-discharge by reducing other once through cooling water discharges, it will not significantly reduce contaminant loading. As well, the temperature of the treated sludge pond effluent presents significant limitations to this proposal.

Evaporating process effluents, or using closed-loop air cooling systems to eliminate cooling water discharges, are not effective in this part of Ontario, where precipitation rates are almost equal evaporation rates, and warm seasonal temperatures are experienced.

Technologies to advance this plant further towards zero-discharge of contaminants were outlined in BAT Option 4. Therefore, BAT Option 5 includes measures outlined in the discussion of BAT Option 4.

### 3.6 Summary

Table 5 summarizes BAT Options for Cyanamid (Welland).

<p align="center"><b>Table 5</b>  <b>Summary of BAT Options at Cyanamid (Welland)</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Technology</b>
1	Least cost producing non-lethal effluent	<ul style="list-style-type: none"> <li>• Diversion of DICY barometric condenser condensate to the sludge pond.</li> <li>• Nitrification-denitrification of sludge pond effluent.</li> <li>• Final effluent pH adjustment at CO0200.</li> <li>• Toxicity Reduction Study for dicyandiamide and derivatives.</li> </ul>
2	U.S. BAT	<ul style="list-style-type: none"> <li>• Not defined.</li> </ul>
3	Best demonstrated in Ontario	<ul style="list-style-type: none"> <li>• Existing wastewater management system.</li> </ul>
4	Maximum reduction of pollutants	<ul style="list-style-type: none"> <li>• Diversion of DICY barometric condenser condensate to the sludge pond.</li> <li>• Nitrification-denitrification of condensate/sludge pond effluent.</li> <li>• Filtration of condensate/sludge pond effluent.</li> <li>• Alkaline chlorination of condensate/sludge pond effluent.</li> <li>• Dechlorination of condensate/sludge pond effluent.</li> <li>• Final effluent pH adjustment at CO0200.</li> <li>• Management practices for oil and grease and phenolics control.</li> </ul>
5	Furthest towards zero-discharge of pollutants	<ul style="list-style-type: none"> <li>• Same as BAT Option 4.</li> </ul>

## 4.0

### BAT OPTIONS

BAT Option 2 was not defined for Cyanamid (Welland) and BAT Option 3 involved no changes to the existing wastewater management system. BAT Options 1, 4 and 5 are described in the following subsections. BAT Options 4 and 5 entail the same recommendations.

## 4.1

### BAT Option 1

BAT Option 1 includes implementation of a Toxicity Reduction Study with respect to dicyandiamide and its derivatives. This study would include the following tasks:

- Develop LC50 data for cyanamide, dicyandiamide and related compounds.
- Establish the toxicity of the effluents at CO0200 once BAT Option 1 has been implemented.
- Enumerate potential toxic contaminants remaining, if any.
- Identify sources of potential toxic contaminants remaining, if any.
- Identify alternatives to eliminate toxic contaminants.

- Develop and implement toxicity reduction management program.

Since the scope of these studies cannot be fully defined, based on the available information, especially with respect to sampling and analytical work, costs for these studies have not been developed.

Other recommendations for BAT Option 1 include:

- Redirecting the DICY barometric condenser condensate to the sludge pond for further treatment.
- Biological nitrogen removal treatment of condensate/sludge pond effluent for ammonia nitrogen removal.
- Automated pH control of final effluent at CO0200.

#### **4.1.1 Redirection of DICY Barometric Condenser Condensate**

Since both the barometric condenser condensate and the sludge pond effluent likely contribute to the ammonia levels measured at CO0200, the barometric condenser condensate should be redirected to discharge into the sludge pond for further treatment.

This modification involves combining the DICY diamide lime slurry stream with the barometric compressor condensate in the DICY production area. A larger transfer pipe to the sludge pond would have to be installed to accommodate the increased flow. Alternatively, the treatment plant could be constructed in the DICY area and sludge pond effluent would be transferred to this area. The estimated capital cost associated with the construction, and installation of a 0.7 m diameter gravity feed sewer amounts to \$666,400 (including 35% installation, 30% contingency allowance, 15% engineering and 7% G.S.T.; ENR CCI 6343) (Ref. 7).

#### **4.1.2 Nitrification/Denitrification**

##### **Description**

Ambient temperatures, combined with the effects of the elevated pH, may result in toxic levels of un-ionized ammonia in the condensate/sludge pond effluent as described in Section 3 under BAT Option 1. Therefore, ammonia-nitrogen removal is recommended as described in a general technology report (Ref. 2). Ammonia and nitrate levels are reduced in the nitrification-denitrification system, which consists of coupled biological fluidized bed reactors. The nitrification unit is supplied with pure oxygen, while the denitrification unit may require the addition of methanol as a supplemental carbon source.



## Performance

The estimated performance of implementing nitrification-denitrification under BAT Option 1 is presented in Table 6. As noted in Section 3.0, it has been assumed that total ammonia and nitrate nitrogen loadings are contributed by only the slurry pond effluent and the barometric condenser condensate. Removal efficiencies of 99% were reported in the General Technology Report (Ref. 2) but levels of less than 1 mg/L are not generally reported. Ammonia measured as TKN will be reduced, but the removal efficiency of other nitrogen compounds is not known. Incidental removal of total cyanide may also occur, but is not possible to predict since removal depends on the form of cyanide present.

Table 6 Projected Performance of Implementing Nitrification-Denitrification Under BAT Option 1				
Contaminant	Total Loading <sup>1</sup> (kg/d)	Estimated Influent Concentration (mg/L) <sup>1</sup>	Estimated Effluent Concentration (mg/L) <sup>2</sup>	Loading Reduction (kg/d) <sup>2</sup>
NH <sub>3</sub> /NH <sub>4</sub> <sup>+</sup> as N	211.8	14.2	<1	>197
TKN	747.6	50.2	37.0	197
NO <sub>2</sub> /NO <sub>3</sub> <sup>-</sup> as N	249.0	16.7	<1	>234
Notes:				
1. See Table 4.				
2. Based on 99% removal efficiency, and a lower limit of 1 mg/L achievable, Ref. 8.				

## Costs

Capital costs estimated for a nitrification-denitrification system to treat 14,900 m<sup>3</sup>/d are \$20,300,000.

Costs for the nitrification-denitrification system are based on information from Ref. 2 and include the following items:

- Fluidized bed reactors for nitrification and denitrification including oxygenator pits.
- Clarifier with polymer addition system.
- Mechanical equipment, pumps, piping and valves.
- Installation and site work.
- 35 percent installation.



- 30 percent contingency allowance.
- 15 percent engineering
- 7 percent G.S.T.

Operating costs estimated based on Ref. 2 are \$1.54 million per year and include the following items, but not labour:

- Oxygen supply
- Electricity requirements
- Chemicals for pH adjustment
- Methanol supply
- Sludge disposal.

#### **4.13      Final Effluent pH Control**

##### **Description**

Currently, pH control for the final effluent is conducted on a manual basis, and results in potentially lethal excursions ranging from 5.6 to 8.7. To reduce the occurrence of these excursions, it is recommended that an automated pH adjustment system be installed. The components of this system include:

- A small continuous flow mix tank.
- pH monitoring probes upstream and downstream of the chemical addition points.
- An automatic feedback control system.
- Two chemical feed systems; one for acid addition and one for caustic addition.

Appendix Figure A1 presents a schematic of a typical pH adjustment system.

##### **Performance**

The pH adjustment system will produce effluents with pH in the range of 6.5 to 8.5.

## Costs

Capital costs of the neutralization system, presented in Table 7, are estimated to total \$240,000 (ENR CCI 6343). The main operating cost component will be chemicals. The quantity of chemicals cannot be calculated based on the available information.

### **4.1.4      Summary**

Table 8 summarizes the projected performance and costs of implementing BAT Option 1.

<b>Table 7</b> <b>Estimated Capital Cost of Final Effluent Neutralization System</b>	
<b>Component</b>	<b>Cost<sup>1,2</sup></b>
Chemical storage tank, mix tank and feed systems	\$80,000
Continuous mix reactors	\$100,000
Instrumentation and controls	\$60,000
<b>Total</b>	<b>\$240,000</b>
<b>Notes:</b>  1. Includes 35 percent installation, 30 percent estimating contingency, 15 percent engineering and 7 percent G.S.T. 2. ENR CCI 6343.	

<b>Table 8</b> <b>Summary of Performance and Costs of BAT Option 1<sup>1</sup></b>				
<b>Technology</b>	<b>Capital Cost (\$)</b>	<b>Operating Cost (\$/yr)</b>	<b>Contaminant</b>	<b>Loading Reduction (kg/d) at CO#200</b>
Diverting DICY condensate to sludge pond	666,400	negligible	not applicable	not applicable
Nitrification-denitrification	20,300,000	1,540,000	NH <sub>3</sub> /NH <sub>4</sub> <sup>+</sup> as N TKN NO <sub>2</sub> <sup>-</sup> /NO <sub>3</sub> <sup>-</sup> as N	>197 197 >234
pH adjustment	240,000	unknown	pH (6.5 to 8.5)	not applicable
<b>Total</b>	<b>\$21,206,400</b>	<b>\$1,540,000<sup>2</sup></b>	-	-
<b>Notes:</b>  1. Assumptions for estimates provided in Section 4.1 and Tables 6 and 10. 2. Does not include unknown chemical costs for pH adjustment.				

BAT Options 4 and 5 entail:

- Redirection of the DICY barometric condenser condensate to the sludge pond for further treatment by:
  - Biological removal of ammonia-nitrogen, nitrate-nitrogen and toluene from condensate/sludge pond effluent.
  - Alkaline chlorination for cyanide and sulphide removal from condensate/sludge pond effluent.
  - Dechlorination of alkaline chlorination effluent.
  - Filtration of the condensate/sludge pond effluent for aluminum, TSS and phosphates removal.
- Final effluent pH control at CO0200.
- Management practices for oil and grease and phenolics control.

The costs and details of the redirection of the DICY barometric condenser condensate and treatment of the sludge pond/condensate stream by nitrification/denitrification were presented in the discussion of BAT Option 1 in Section 4.1. In addition, final effluent pH control included in BAT Option 4 was presented.

#### **4.2.1**

##### **Filtration of Condensate/Sludge Pond Effluent**

The proposed filtration system for TSS, aluminum and phosphorus removal entails twin gravity-fed sand filters, connected in parallel, similar to the system in use at Cabot Canada Limited (Ref. 3). This system would follow biological nitrogen removal.

##### **Performance**

The performance of the filter in the removal of TSS and aluminum under BAT Option 4 is summarized in Table 9. The filter should be able to achieve 5 mg/L of TSS, which is comparable to the performance of a similar system at Cabot Canada Limited (Ref. 3).

Results for aluminum are based on the assumption that aluminum will be removed with the same efficiency as suspended solids in the filtration system, since it is most likely present in a particulate form in the sludge pond. It should be noted that the effluent

aluminum level achieved (0.10 mg/L) is the lower limit of concentration achievable owing to the solubility of aluminum in natural water.

Total phosphorus removals are also reported in Table 9. These removals are based on the arbitrary assumption that 50 percent of the total phosphorus present is in a solid form and is removable by filtration.

The aluminum TSS, and phosphorus loadings to the filter include those measured at Control Point CO0400 for the sludge pond effluent and assuming the intake water concentrations for the barometric condenser condensate, since these contaminants would not likely be contributed in the condenser operation. Intake water concentrations are (Ref. 13):

- Aluminum - 1,970 µg/L
- TSS - 54.8 mg/L
- Phosphorus - 0.15 mg/L

<p align="center"><b>Table 9</b> <b>Projected Performance of Implementing Filtration Under BAT Option 4</b></p>				
Contaminant	Loading <sup>1</sup> (kg/d)	Influent Concentration <sup>2</sup> (mg/L)	Effluent Concentration <sup>2</sup> (mg/L)	Loading Reduction (kg/d)
TSS	634	42.6	5.0 <sup>3</sup>	560.2
Al	21.2	1.42	0.17	18.6
Total Phosphorus	11.6	0.77	0.38	5.7
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Loadings include those measured at existing CO0400 and those contributed from barometric condenser condensate (assumed to be the same as raw water quality).</li> <li>2. Condensate/sludge pond effluent has a flowrate averaging approximately 14,900 m<sup>3</sup>/d (see Section 3).</li> <li>3. Ref. 3.</li> </ol>				

## Costs

Capital costs of the filtration system appear in Table 10.

Costs include:

- Installation at 35 percent.
- Contingency allowance at 30 percent.
- Engineering at 15 percent.
- G.S.T. at 7 percent.

**Table 10**  
**Capital Cost of Filtration Ponds**

Capital Cost Item	Cost
Distribution trough, piping, level control chamber	\$193,500
Site work	452,800
Filtration section	81,300
<b>Total</b>	<b>\$727,600</b>

Operating costs will be largely dependent on the amount of solids requiring disposal when the filtration ponds are cleaned. If solids are removed by vacuum truck and hauled away as a slurry at five percent solids for \$50/m<sup>3</sup>, operating costs would be approximately \$86,000 per year.

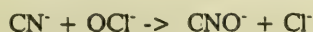
#### **4.2.2      Removal of Cyanide by Alkaline Chlorination**

##### **Description**

The oxidation of cyanide using alkaline chlorination should be considered for treating the condensate/sludge pond effluent, following the nitrification/denitrification and filtration processes. This process should be followed by dechlorination.

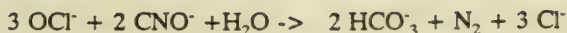
Chlorination may be accomplished by either addition of sodium hypochlorite solution, or addition of chlorine gas plus sodium hydroxide. The net result of both of these processes is the reaction of cyanide with hypochlorite, since the addition of chlorine gas and sodium hydroxide results first in the formation of hypochlorite. Accordingly, the following paragraphs describe the reaction of cyanide with hypochlorite. While chlorine gas/sodium hydroxide treatment is approximately half as expensive as sodium hypochlorite addition, the associated handling and equipment costs are higher. The following costs are based upon chlorine gas and sodium hydroxide addition.

The complete oxidation of cyanide is a two-stage process. In the first stage of the process, cyanide is oxidized to cyanate, over 0.5 hr to 2 hr. The first stage of this reaction requires vigorous agitation to prevent solid cyanide precipitates from forming. During this stage, the pH of this mixture should be maintained at >10, and the ORP (oxidation-reduction potential) should be maintained at 350 to 400 mV. The net reaction in the first stage of this process follows:



The second stage of the oxidation process involves the addition of acid, to reduce the pH to 8.0 to 8.5. The cyanate will then be oxidized by the following reaction.





The addition of the hypochlorite should be adjusted to maintain the ORP at 600 mV. The pH must not be allowed to drop below 8 to avoid the formation of highly toxic cyanogen chloride gas or chlorophenols. At this point, the treated water should be suitable for discharge following dechlorination.

The rate of chemical dosage should be based on the results of jar tests especially since there is no information on whether dicyandiamide and its derivatives exert a chlorine demand. The typical dosage rates used to cost this system include:

- 1.75 g of chlorine gas for every gram of cyanide, for the first stage of oxidation.
- 4.3 g of chlorine gas for every gram of cyanide, for the second stage of oxidation (Ref. 4 ).

The components of the system include:

- Two stage concrete reaction vessel.
- Agitators (2).
- Chlorine feed system
  - chlorine vaporizer
  - chlorinator
  - circulation pumps (2)
- Piping, instrumentation, electrical
- Metal shed
- pH and ORP control.

### Performance

The oxidation of cyanide can potentially reduce cyanide levels to zero (Ref. 4). However, strict pH and ORP control will be required to reach this goal.

It should also be noted that the oxidation by chlorination will reduce levels of sulphide. The predicted performance of this system is presented in Table 11.

**Table 11**  
**Predicted Performance of Alkaline Chlorination of Condensate/Sludge Pond Effluent**

Parameter	Current Quality	Projected Quality	Loading Reduction
Total Cyanide (kg/d)	2.336 <sup>1</sup>	0 <sup>2</sup>	100%
Total Cyanide (mg/L)	0.157 <sup>1</sup>	0 <sup>2</sup>	
Sulphide (kg/d)	0.223 <sup>3</sup>	0 <sup>2</sup>	100%
Sulphide (mg/L)	19.7 <sup>3</sup>	0 <sup>2</sup>	

Notes:

1. See Table 4.
2. Based on achievable levels (Ref. 4).
3. Based on the assumption that the source of sulphide in the condensate/sludge pond effluent is the sludge pond (CO0400) only. Concentrations are based on the sludge pond loading (0.223 kg/d) divided by the condensate/sludge pond effluent flow rate (14,900 m<sup>3</sup>/d).

## Costs

The capital costs for cyanide removal are presented in Table 12.

**Table 12**  
**Estimated Capital Costs for Cyanide Removal System**

Component	Estimated Capital Cost <sup>1</sup>
<b>Alkaline Chlorination Unit</b> <ul style="list-style-type: none"> <li>• Includes 2 stage concrete reaction vessel, two mechanical agitators, chlorine feed system (chlorine vaporizer, chlorinator and two circulation pumps), piping, instrumentation, electrical, metal shed, pH and ORP control.</li> </ul>	\$4,510,000 <sup>2</sup>
Notes:	
1. Capital costs include 35 percent installation, 30 percent estimating contingency, 15 percent engineering, and 7 percent G.S.T.	
2. Ref. 8.	

The operating costs for this system are difficult to predict, since the chemical dosage required for pH adjustment depends on the buffering capacity of the wastewater. The estimated chlorine and caustic soda (50% solution) costs based upon the estimated chemical requirements are presented in Table 13.

Table 13 Estimated Annual Operating Costs	
Chemical	Operating Costs
Chlorine Gas	\$6,800/y <sup>1</sup>
Caustic Soda	\$7,400/y <sup>2</sup>
Notes:	
1. Based upon 6.05 g Cl <sub>2</sub> /g CN <sup>-</sup> total for both stages of oxidation. Costs provided by Harcos Chemicals Canada Inc.	
2. Based upon 6.05 g of NaOH/g of CN <sup>-</sup> total for both stages of oxidation. Costs provided by Canada Colours and Chemicals Limited.	

Other requirements, including power, labour and chemical dosages, are not included in these operating costs.

### 4.2.3 Dechlorination

#### Description

In order to reduce the possibility of toxic effluents, the effluent from the alkaline chlorination unit should be dechlorinated. The details of the design parameters were described in a general technology report (Ref. 9).

#### Performance

Theoretically, residual chlorine can be reduced to zero using this technology (Ref. 9). However, limitations in the instrumentation used to monitor residual chlorine and control chemical doses make this difficult to achieve in practice. Regardless, residual chlorine will be reduced to below toxic levels.

#### Costs

The capital costs for a sodium metabisulphide dechlorination system, including installation amounts to \$162,900 (1991) (Ref. 9). Based upon 1 mg/L of residual chlorine in the alkaline chlorination system effluent, the sodium metabisulphite costs amount to \$21,800/yr (Ref. 9).

Description

Management practices for source control of oil and grease and phenolics releases will include diligent collection of oils during equipment maintenance and repair, routine inspection of equipment for oil leaks, containment of high risk and spill areas, placement of absorbent socks and pads around equipment, employee training on oil spill procedures, etc.

Performance

The performance of management practices for source control of oil and grease and phenolics, and other management practices, may be estimated by examining monitoring data in more detail. The performance summarized in Table 14 has been estimated by assuming that the plant will achieve the lowest monthly mean concentration for these contaminants on a consistent basis. Note that these concentrations are not the minimum values recorded in Tables A1 and A2, but are the lowest monthly mean concentrations. Also note that loading reductions achieved at CO0400 are reflected in the estimates for the final effluent, CO0200, and that these figures should not be added.

<b>Table 14</b> <b>Projected Performance of Oil and Grease and Phenolics Management Practices</b> <b>Under BAT Option 4</b>					
Control Point	Contaminant	Existing		Projected	
		Concentration	Loading (kg/d)	Concentration <sup>1</sup>	Loading <sup>2</sup> (kg/d)
CO0200	Oil and Grease	2.01 mg/L	45.69	1.025 mg/L	23.3
	Phenolics	2.58 µg/L	0.064	1.00 µg/L	0.025
CO0400	Oil and Grease	1.5 mg/L	8.652	1.1 mg/L	6.345
	Phenolics	2.7 µg/L	0.021	1.00 µg/L	0.008
Notes: 1. Lowest monthly mean concentration for 12 months of MISA monitoring (not minimum values from Tables A1 and A2). 2. Calculated based on percentage reduction in concentration.					

Costs

Costs for implementing management practices for oil and grease and phenolics cannot be calculated in detail, since the necessary changes to the plant and employee training could not be defined within the scope of the study. It is reasonable to assume, however, that these costs would be relatively small for minor changes around the plant such

as containment implementation. Negligible costs were also assumed for including oil control procedures in staff training programs, and other routine operating requirements.

#### 4.2.8 Summary

Table 15 summarizes the projected performance and costs of implementing BAT Option 4 or 5.

<p align="center"><b>Table 15</b> <b>Summary of Performance and Costs of BAT Option 4 and 5<sup>1</sup></b></p>				
<b>Technology</b>	<b>Capital Cost (\$)</b>	<b>Operating Cost (\$/yr)</b>	<b>Contaminant</b>	<b>Loading Reduction (kg/d) at CO0200</b>
Diverting DICY condensate to sludge pond	666,400	negligible	not applicable	not applicable
Nitrification-denitrification	20,300,000	1,540,000	NH <sub>3</sub> /NH <sub>4</sub> <sup>+</sup> as N TKN NO <sub>2</sub> <sup>-</sup> /NO <sub>3</sub> <sup>-</sup> as N	>197 >197 >234
Filtration pond	727,600	86,000	TSS Al TP	560.2 18.6 5.7
Chlorination	4,510,000	14,200	CN <sup>-</sup> S <sup>-</sup>	2.336 0.223
Dechlorination	162,900	21,800	OCl <sup>-</sup>	not available
Final effluent pH adjustment	240,000	unknown	pH (6.5 to 8.5)	not applicable
Management practices for oil and grease and phenolics	negligible	negligible	Oil and grease Phenolics	23.3 0.025
<b>Total</b>	<b>\$26,606,900</b>	<b>\$1,662,200<sup>2</sup></b>	-	-
<p>Notes:</p> <ol style="list-style-type: none"> <li>Estimates based on assumptions presented in Section 4.1 and 4.2 and Tables 6 to 14.</li> <li>Does not include unknown chemical costs.</li> </ol>				

#### 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 16 presents a summary of estimated costs and performance of implementing BAT Options at Cyanamid (Welland).



**Table 16**  
**Summary of Cost and Performance of BAT Options<sup>1</sup>**

Component	BAT Option 1	BAT Option 2	BAT Option 3	BAT Options 4 and 5
<b>Cost</b>				
Capital	\$21,206,400	0	0	\$26,366,900
Operating	\$1,540,000	0	0	\$1,662,000
<b>Performance (Contaminant Loading Reduction kg/d)</b>				
TSS	0	0	0	560.2
Al	0	0	0	18.6
TP	0	0	0	5.7
NH <sub>3</sub> /NH <sub>4</sub> <sup>+</sup> as N	>197	0	0	>197
TKN	>197	0	0	>197
NO <sub>2</sub> <sup>-</sup> /NO <sub>3</sub> <sup>-</sup> as N	>234	0	0	>234
Cyanide	0	0	0	2.336
Sulphide	0	0	0	0.223
Oil and grease	0	0	0	23.3
Phenolics	0			0.025
Notes:				
1. Estimates based on assumptions presented in Section 4.1 and 4.2 and Tables 6 to 14.				

## 6.0 REFERENCES

1. Inorganic Chemical Sector Plants, Site Visit Report, Cyanamid Canada Inc. (Welland). March 27, 1991. (unpublished).
2. General Technology Report, Biological Nitrogen Removal.
3. Sister Plant Technology Report - Coagulation/Sedimentation/Filtration Ponds at Cabot Canada Limited.
4. Patterson, James W. Industrial Wastewater Technology, 2nd Edition. Toronto. Butterworth-Heinemann, 1985.
5. Environment Canada. Mine and Mill Wastewater Treatment. Report EPS 2/MM/3, December, 1987.
6. Inorganic Chemical Sector Plants, Site Visit Report, Cyanamid Canada Inc. (Niagara).
7. General Technology Report-Pumping Stations, Forcemains and Sewers.
8. U.S. EPA. Treatability Manual Volume IV: Cost Estimating. EPA-600/2-82-001d, April 1983.

9. General Technology Report, Dechlorination.
10. R. V. Thurston, R.C. Russo, Ammonia Toxicity to Fishes. Effect of pH on the Toxicity of the Un-ionized Ammonia Species, Environmental Science and Technology. Vol. 15, No. 7, July 1981.
11. Water Quality Criteria for European Fresh Water Fish, Water Research, Vol. 7, 1973.
12. Proposed Ontario Provincial Water Quality Guidelines and Objectives. Ontario Ministry of the Environment. November 1990.

## **APPENDIX**

### **Figure and Tables**



**Table A1, Cyanamid Canada Inc. (Welland Plant)**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0200

Description: Millers Creek - Combined

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	8940	199000	28700	
COD	mg/L	28	44	36	945.428
Cyanide Total	mg/L	0.002	0.662	0.093	2.336
Hydrogen Ion (pH)		5.6	8.7	6.76	
Ammonia Plus Ammonium	mg/L	1.6	20.3	7.9	211.83
Total Kjeldahl Nitrogen	mg/L	4.2	107.1	28	747.632
Nitrate and Nitrite	mg/L	1.6	40	7.4	249.042
DOC	mg/L	4.2	43	15.6	359.788
TOC	mg/L	5.3	51	15.5	366.931
Total Phosphorus	mg/L	0.08	0.84	0.84	23.283
Specific Conductance	uS/cm	308	989	515	
Total Suspended Solids	mg/L	1	358	21	1046.412
Aluminum	ug/L	21	5500	789	29.64
Strontium	ug/L	42	350	234	5.537
Zinc	ug/L	4	79	14	0.381
Antimony	ug/L	3	12	6.1	0.122
Phenolics (4AAP)	ug/L	0.3	21	2.58	0.064
Oil and Grease	mg/L	1	19	2.01	45.69
Chloride, Unfiltered Reactive	mg/L	27	41	34	891.907
Fluoride, Unfiltered Reactive	mg/L	0.3	0.4	0.35	9.142
Sulphate, Unfiltered Reactive	mg/L	96	120	108	2814.744



**Table A2, Cyanamid Canada Inc. (Welland Plant)****Summary of Flows and Priority One Pollutants****MISA Control Point: CO0400****Description: Sludge Road # 11**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	3	78600	7950	
COD	mg/L	6.2	61	37	224.632
Cyanide Total	mg/L	0.01	0.782	0.204	1.052
Hydrogen Ion (pH)		7.2	9.1	8	
Ammonia Plus Ammonium	mg/L	1.3	57.3	15.9	59.186
Total Kjeldahl Nitrogen	mg/L	6.4	134.7	62.1	263.223
Nitrate and Nitrite	mg/L	1.8	120	13	75.16
DOC	mg/L	0.35	53	28.4	116.745
TOC	mg/L	8.7	48	23	103.097
Total Phosphorus	mg/L	0.2	13	2.5	11.516
Specific Conductance	uS/cm	210	110	597	
Total Suspended Solids	mg/L	3	80	33	357.35
Aluminum	ug/L	3	2000	1000	7.254
Strontium	ug/L	170	360	239	1.342
Zinc	ug/L	2	40	12	0.09
Arsenic	ug/L	3	19	6.3	0.026
Antimony	ug/L	3	11	5.6	0.02
Phenolics (4AAP)	ug/L	1	7	2.7	0.021
Sulphide	ug/L	19	50	37	0.223
Toluene	ug/L	0.05	97	2.1	0.012
Oil and Grease	mg/L	1	8	1.5	8.652
Chloride, Unfiltered Reactive	mg/L	26	70	46	306.084
Fluoride, Unfiltered Reactive	mg/L	0.4	0.5	0.42	2.652
Sulphate, Unfiltered Reactive	mg/L	82	140	107	650.598

**Table A3 Cyanamid Canada Inc. (Welland Plant)**

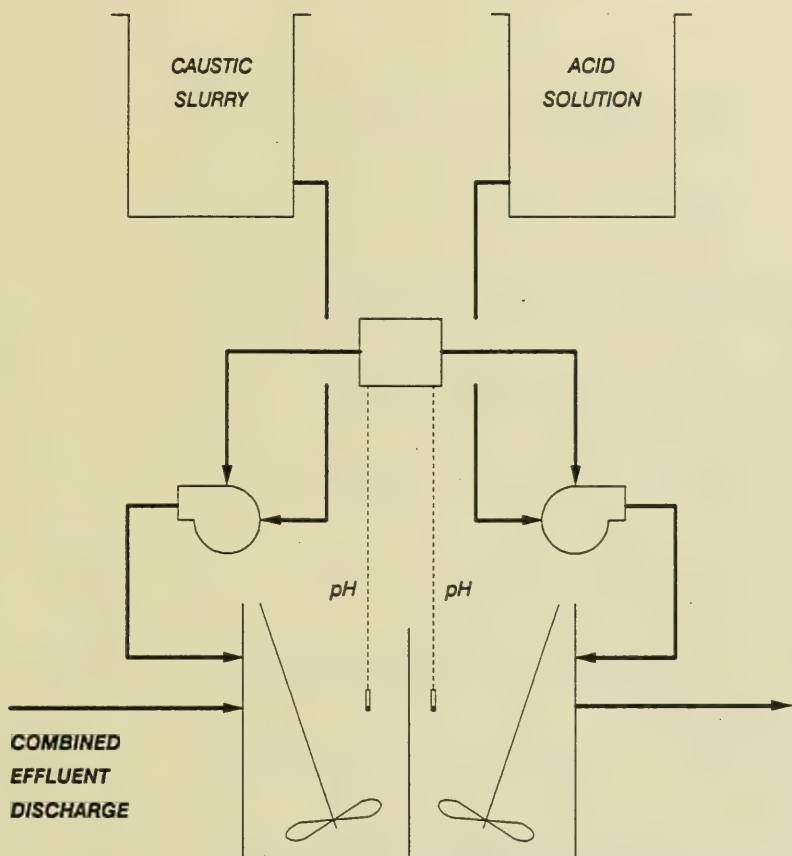
Summary of Flows and Priority One Pollutants

MISA Control Point: OT1300

Description: Once through non-contact cooling water

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	207	5000	2770	
DOC	mg/L	1	16	5.8	4
Total Phosphorus	mg/L	0.03	0.26	0.091	0.23
Specific Conductance	uS/cm	300	411	338	
Total Suspended Solids	mg/L	8	140	34	8204

<b>Table A4</b> <b>Toxicity Data for Cyanamid Canada Inc. (Welland) for the First Six Months of</b> <b>MISA Monitoring Regulation</b>				
<b>MISA Control Point</b>	<b>Test Species</b>	<b>Number of Samples</b>	<b>Range of Lethal Concentration Data</b>	<b>Number of Non- Lethal Samples</b>
CO0200	Rainbow trout	7	80.7% to non-lethal	3
	<u>Daphnia magna</u>	5	20.8% to 40.6%	none
OT1300	Rainbow trout	2	>100%	none
	<u>Daphnia magna</u>	1	Non-lethal	1



**Figure A1**  
**TYPICAL pH ADJUSTMENT SYSTEM**  
**RECOMMENDED UNDER BAT OPTION 1**

**Cyanamid**  
**Niagara Falls**  
**(Welland Plant)**

ATG	PARAMETER	CONCENTRATIONS						LOADINGS kg/d				
		RMDL	UNIT	CO0200	CO0400	OT0300	IN1500	CO0200	CO0400	OT0300	IN1500	
c	Total suspended solids	5	mg/L	18.2	32.7	34.1	54.8	703	255	82.4	1590	
c	Hydrogen ion (pH)			6.74	8.1	8.01	7.92					
c	Specific conductance		uS/cm	512	600	339	328					
c	DOC	0.5	mg/L	15.6	28.5	5.76	5.6	360	117	15.2	162	
c	TOC		mg/L	15.5	29.4		7.9	367	104			
c	Oil and grease	1	mg/L	2.01	1.47	1.017	1.1	45.7	8.65	2.81	229	
c	Ammonia, plus Ammonium	0.25	mg/L	8.16	16.8		0.137	208	57.4		31.8	
c	Nitrate+Nitrite	0.25	mg/L	7.21	13.7		1.06	221	69.7		3.97	
c	Total Kjeldahl nitrogen	0.5	mg/L	29.1	64.1		1.03	731	258		30.6	
c	Total phosphorus	0.1	mg/L	0.846	2.63	0.091	0.149	21.7	10.6	0.228	29.9	
09	Aluminum	30	ug/L	788	1130		1970	29.5	7.97		4.32	
09	Strontium	20	ug/L	234	239		285	5.54	1.34		57	
09	Zinc	10	ug/L	14.3	11.6		9	0.381	0.09		8.26	
10	Antimony	5	ug/L	5.17	5.21		4	0.103	0.019		0.261	
10	Arsenic	5	ug/L	2.88	5.79		3	0.064	0.024		0.116	
12	Mercury	0.1	ug/L	0.148	0.018		0.66	0.003	—		0.087	
14	Phenolics (4AAP)	2	ug/L	2.58	2.67		2.5	0.064	0.021		0.019	
15	Sulphide	20	ug/L	69.5	37.3		34.5	1.89	0.223		0.072	
17	Toluene	0.5	ug/L	0.592	2.11		0.4	0.013	0.012		1	
23	Hexachloroethane	10	ng/L	1.35	16.3		30.9	—	—		0.012	
24	Octachlorodibenzo-p-dioxin	30	pg/L	225	90		290	—	—		0.001	
2	Cyanide Total	0.005	mg/L	0.097	0.204		0.002	2.4	1.05		—	
98	Flow		m3/d	26200	7360	2770					0.058	
11	Chloride	2	mg/L	34	46			892	306		638	
12	Fluoride	0.1	mg/L	0.350	0.425		0.150	9.14	2.65		4.35	
13	Sulphate	5	mg/L	108	107		42.5	2810	651		1230	

Notes:

CO0200 is the "Millers Creek final discharge" and this joins the Welland River.

CO0400 is the stream named "Sludge Pond #11"; this discharges into CO0200.

OT1300 is the "DICY Cooling Water" stream which also flows into the Welland River.

Intake loadings are calculated from the reported analytical data and the sum of CO0200 and OT1300 flows. These intake loadings represent probable upper bounds because of rainfall contributions to the flow.



## **APPENDIX 8**

**Explosives Technology International (Canada)**



**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
EXPLOSIVES TECHNOLOGY INTERNATIONAL (ETI) CANADA LTD.**

**1.0      PLANT DESCRIPTION**

Explosives Technology International (ETI) Canada Ltd. manufactures and packages a number of commercial blasting explosives including:

- Monomethylamine nitrate (MMAN).
- Water gel explosives.
- Ammonium nitrate/fuel oil explosives (ANFO).
- Tovan WR (a water gel/ANFO mixture).

The MMAN is produced by reacting monomethylamine with nitric acid. The product is cooled and either used in the water gel explosive manufacturing process, or is shipped offsite by tanker truck.

The production of ammonium nitrate/fuel oil (ANFO) explosives involves spraying ammonium nitrate prills (small porous pellets) with dyed No. 2 fuel oil. The product is packaged into 25 kg plastic bags ready for distribution to the customers.

Water gel explosives are primarily comprised of a solution containing MMAN and ammonium nitrate. A number of other ingredients are also incorporated into the product using a mechanical mixer. The resulting product is extruded and packaged.

The production of Tovan WR is basically a mixing operation involving a large proportion of ANFO and lesser amounts of water gel explosives and amorphous silica.

Intake water is pumped at a rate of 2,500 m<sup>3</sup>/d from Lake Nipissing. Water used for domestic purposes is filtered and chlorinated, while once through non-contact cooling water is simply filtered. Boiler make-up water used for steam production is filtered and softened. The process water, which is water used for product washing is untreated. An unknown portion of this intake water supplies a neighbouring polyolefins plant (Fabréne) and a reserve for fire fighting needs.

Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

## 2.0

## WASTEWATER SOURCES AND QUALITY

### 2.1

### Sources

All domestic sanitary flows are treated in a segregated septic system.

The effluent sources, and the mean flows for each MISA Control Point are presented in Table 1.

Table 1 ETI MISA Monitoring Points			
MISA Control Point Number	Plant Name for Control Point	Effluent Sources	Flow <sup>1</sup> (m <sup>3</sup> /d)
OT0100	Main Weir	<ul style="list-style-type: none"><li>• Storm water<ul style="list-style-type: none"><li>- main plant and acid plant (including Tovan WR and water recycling system buildings)</li></ul></li><li>• Power house<ul style="list-style-type: none"><li>- non-contact cooling water</li><li>- raw water storage tank overflow</li><li>- backwashes from water treatment units</li></ul></li></ul>	885
ST0300	West Storm Ditch	<ul style="list-style-type: none"><li>• Storm water<ul style="list-style-type: none"><li>- ammonium nitrate unloading</li><li>- ANFO production buildings</li><li>- main water gel production buildings</li></ul></li></ul>	Not available
ST0400	Cook's Creek	<ul style="list-style-type: none"><li>• Storm water<ul style="list-style-type: none"><li>- landfill areas</li><li>- evaporation pond</li><li>- burning grounds</li><li>- product testing buildings</li><li>- southern areas of plant site</li></ul></li></ul>	9,046
ST0500	Beaver Pond Storm Ditch	<ul style="list-style-type: none"><li>• MMAN non-contact cooling water</li><li>• Storm water<ul style="list-style-type: none"><li>- MMAN production buildings</li><li>- No. 2 magazine</li></ul></li></ul>	Not available
Notes:			
1. Mean flow from 12 month MISA Monitoring Regulation data.			

All process wastewaters are collected in holding tanks, which are periodically emptied by trucks equipped with vacuum pumps and transferred to an onsite evaporation pond. No discharge of the effluent from the evaporation pond occurs. Some product wash water is treated for solids removal and recycled before discharge to the evaporation pond. Boiler blowdown is also discharged to the onsite evaporation pond.

Solid residues from the pond are landfilled onsite. Contaminated packaging, and solids removed from washwater are burned in a low-lying natural area which has no provision for leachate or runoff control.

The only wastewater that is discharged directly includes:

- Backwashes from the water treatment units (filtering and softening) at a rate of 17.0 m<sup>3</sup>/d to OT0100.
- Two sources of once through non-contact cooling water.
  - Cooling water for the boiler pump bearings is discharged to OT0100 at a rate of 32 m<sup>3</sup>/d.
  - Cooling water for the monomethylamine nitrate reactor building is discharged at a rate of approximately 79 m<sup>3</sup>/d to ST0500.

Neither of these sources receive treatment prior to discharge.

Storm water from the developed areas of the site discharge through Control Points OT0100, ST0300, ST0400 and ST0500. There is no storm sewer system at the site and runoff from production, storage and disposal areas flow by ditch to the receiving waterway with no treatment.

## 2.2 Wastewater Flows and Quality

Appendix Table A1 presents the average, maximum and minimum flow and concentration for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point OT0100, at Explosives Technologies International (ETI).



### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for wastewater management, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed in the following discussion.

#### BAT Option 1

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Appendix Table A1. Of the two trout samples tested, both were non-lethal. Of the two samples tested with Daphnia magna, one was non-lethal and the other had a lethal concentration greater than 100 percent. Since all the samples were essentially non-lethal, the existing wastewater system at ETI is considered to be BAT Option 1.

#### BAT Option 2

Under 40 CFR of the U.S. Federal Register (July 1, 1989 edition), BAT for explosives load, assemble and pack plants (Part 457, Subpart C) was not defined. However, Best

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Practicable Technology (BPT) was defined for the control of TSS, oil and grease and pH in discharges from these facilities.

ETI in North Bay exceeds these requirements in as much as there are no direct discharges of process related effluent. For the sake of comparison, loadings at Control Point OT0100 are compared to BPT limits in Table 2.

Thus, although maximum TSS values are somewhat high at OT0100, ETI may be said to be in compliance with U.S. BPT since TSS in these effluents most likely results from storm water and not from production processes. BAT Option 2 is the existing wastewater management system at ETI North Bay.

Table 2 Comparison of ETI Control Point OT0100 to U.S. BPT		
Contaminant	U.S. BPT Maximum Daily Loading (kg/d) <sup>1</sup>	ETI Control Point OT0100 Maximum Loading (kg/d)
Oil and Grease	20	5.40
TSS	48	61.6
pH	Note 2	Note 3
Notes:		
1. Calculated based on nameplate production capacity at ETI North Bay, (Ref. 1).		
2. Range for pH: 6.0 to 9.0.		
3. All pH readings in the range 6.5 to 8.5 and therefore in compliance.		

### **BAT Option 3**

ETI is the only direct discharging explosives producer in Ontario. Thus, the recommended BAT Option 3 is the existing wastewater management system at ETI.

### **BAT Option 4**

BAT Option 4 is intended to provide maximum overall pollution control. Examination of the effluent quality at OT0100 reveals that opportunities for addition of pollutants in once through cooling water operations do not exist. This is supported by the data in Appendix Table A1. The majority of the "Priority 1" contaminants in this stream are not associated with the raw materials or the products at the plant and are most likely originating in the intake water source or storm water.

Although the level of oil and grease is low (1.49 mg/L), an oil absorption column presented in the General Technology Report (Ref. 3) could be used to reduce these levels if required. Alternatively, pollution prevention activities could be exercised at the plant site to reduce contamination of storm water.

There is no obvious source of aluminum in the power house effluents (see Table 1). Since the data vary considerably from 160  $\mu\text{g/L}$  to 4,600  $\mu\text{g/L}$ , it also seems unlikely that raw water is a source. This contention is supported by the fact that aluminum levels at storm water control points in surface waterways at the site are well below 1,000  $\mu\text{g/L}$ . Storm water sources may account for the variability in these readings and granular aluminum is a raw material in the production of water gel explosives. The aluminum unloading area drains to Control Point OT0100 and is likely at major source of aluminum loadings. A storm water management study would confirm or refute this assertion.

Methods to treat these levels of aluminum are available and the most common of these is precipitation (Ref. 8). However, the following disadvantages of treatment are judged to outweigh the benefits of improved wastewater quality:

- Optimal pH for precipitation is 6.5 to 8.5. Effluents are already in this range and precipitation may not result in any further improvement.
- Aluminum precipitates typically have poor settling characteristics and produce large amounts of residuals (i.e. sludge) for disposal.
- Sludges are difficult to dewater. Thus, dewatering may not alleviate the residuals problem.

BAT Option 4 does not include measures for the treatment of aluminum.

Coagulation, settling and filtration could be used to reduce the total suspended solids concentration from 11.8 mg/L to 5 mg/L (Ref. 4). This approach will also provide for incidental removal of aluminum. However, implementation of coagulation/settling/filtration system will produce related problems which must be addressed, including:

- The impacts of water treatment chemicals on effluents, in terms of contaminant concentrations and toxicity.
- The handling and disposal of wastewater treatment residuals.
- The dependence of system reliability and operator training on performance.

Because of these problems and the very low levels of TSS in the effluent, technologies to reduce TSS are not recommended in BAT Option 4.

Alkaline chlorination is the only treatment technology available to treat the levels of ammonia present. However, disadvantages, including possible formation of toxic or noxious by-products and the necessity to dechlorinate effluents, are judged to outweigh the improvement in water quality which would result at ETI.

Levels of nitrate present may be treatable through various concentration technologies. However, since nitrate is a readily-absorbed plant nutrient and is not a growth-limiting nutrient, its discharge to surface waters is not a concern in this instance in comparison to the disadvantages of concentration technologies.

Both ammonia and nitrate are likely originating in the storm water at OT0100 since these materials are handled in that drainage area. No sources exist in the power house effluents (see Table 1). Thus, a storm water management study may be required to identify control measures for these contaminants. Otherwise BAT Option 4 does not include measures for the control of ammonia and nitrate.

Technologies for the removal of low levels of the remaining contaminants present in the effluent at Control Point OT0100 may be available and have been used in specific non-industrial applications (e.g. drinking water treatment); however, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, recommendations for BAT Option 4 do not include technologies for the removal of these contaminants.

Solids removed from process wash water through settling and filtration, and contaminated packaging, are burned daily in a low-lying natural area which has no provision for leachate or runoff control. The burning grounds operate under a Certificate of Approval from the Ministry of the Environment. Storm water originating or passing through the burning area may be considered a process effluent since it comes into direct contact with the product, or the combustion residuals of the product. If ETI is to exercise maximum pollution reduction, control of this potential source of contamination should be considered.

A global search was conducted to identify an alternative method for disposing of the solid waste generated in the water gel explosives process. A recycle process which involves acid hydrolysis of off-specification water gel products and water gel process wastes, was developed by ETI, Seneca Works (Ref. 2). Although concentrated recovered nitrate solution is reused in product formulation, the presence of metals in the water gel wastes (i.e. fine powder aluminum) results in a considerable potential for fire or explosion. In addition, sludges from the process must be landfilled offsite and process upsets are common. The water recycle and burning process in place at North Bay is much less hazardous than the acid hydrolysis recycle process in place at Seneca and, therefore, is the preferred method of treatment.



Maximum pollution reduction would involve burning in an area where storm water can be collected and contained for approved disposal. ETI should consider burning wastes in a concrete bermed area which is sloped to allow collection of storm water. This option is discussed in more detail in Section 4.0.

A second alternative involves prevention of storm water contamination by covering the existing burning area with a tarp or similar device when it is not in use. However, the success of such a device in preventing storm water contamination would be highly dependent on operator care. In addition, fire safety would demand that the covering remain off the burning area until all burning had completely finished. It is possible, then, that storm events may occur while the cover is off the area. Since the burning area is located in an area of the plant site which is staffed only during burning operations, a passive storm water contamination collection system is judged to be the most reliable technology for management of storm water from this area.

In summary, recommendations for BAT Option 4 include:

- A Source Identification and Control Study<sup>2</sup> for aluminum, ammonia and nitrate. This effort may lead to a storm water management study since storm water is a likely source of these contaminants.
- Installation of a concrete burning area, sloped to allow containment of storm water.

### **BAT Option 5**

A recommended option for zero discharge of process water was discussed in the previous section, BAT Option 4.

Additional technologies that would advance the plant further toward zero-discharge were not identified in a global search. Cooling water provided by once through non-contact and recirculation cooling tower systems are invariably used to cool process equipment in industrial manufacturing. Other cooling methods, such closed-loop air cooled systems, would require very large capital expenditures, power consumption and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Thus, this approach to cooling is not used.

BAT Option 5 recommendations are the same as those presented under BAT Option 4.

---

2

Source Identification and Control Study involves an audit of the possible sources of this contaminant. Reduction or elimination of this contaminant in the final effluent may be based on source controls through process changes, materials substitution, improved air emission quality, best management practices, or through storm water management.



## Summary

The BAT Options for ETI are summarized in Table 3.

<b>Table 3</b> <b>Summary of BAT Options for Explosive Technologies International Ltd.</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	No change to existing system.
2	U.S. BAT	No change to existing system.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum overall pollution reduction	Contain burning area.
5	Furthest towards zero-discharge of pollutants	BAT Option 4.

### **4.0      BAT OPTIONS**

The recommendations for BAT Options 1, 2 and 3 were no changes to the existing system. Options 4 and 5 are described below.

### **4.1      BAT Options 4 and 5**

For BAT Options 4 and 5, a bermed, concrete burning area with storm water collection is recommended. Since the existing evaporation pond system is currently at capacity (Ref. 6), this option also includes the construction of a clay-lined evaporation pond. This recommendation is based on the assumption that air emissions from the burning operation meet air quality requirements.

Figure A1 presents a schematic diagram of the bermed burning area and storm water collection system. The bermed burning area is sloped to allow for collection of storm water and lined with fire brick. The burning pad is reinforced and underlain with sand or gravel to allow for uneven settling (i.e. a floating slab). A discharge pipe transfers collected wash water to an underground sump. The transfer pipe and the storm water collection sump is insulated to prevent freezing of the collected storm water. Because of the isolated location of the burning area, it is recommended that the storm water collected in the underground sump is transferred by vacuum truck to an evaporation pond.

The actual design specifications for the system are presented in Table 4.

<p style="text-align: center;"><b>Table 4</b>  <b>Design Parameters for BAT Option 4 for ETI</b></p>	
<b>Component</b>	<b>Description</b>
<b>Burning Pad</b> <ul style="list-style-type: none"> <li>• diameter</li> <li>• height of berms</li> <li>• thickness of base</li> <li>• depth of sand/gravel underlay material</li> </ul>	<p>10 m</p> <p>0.5 m</p> <p>0.4 m</p> <p>0.3 m</p>
<b>Storm Water Collection Sump</b> <ul style="list-style-type: none"> <li>• volume</li> </ul>	<p>1.5 m<sup>3</sup></p>
<b>Evaporation Pond</b> <ul style="list-style-type: none"> <li>• surface area</li> <li>• depth</li> <li>• volume</li> </ul>	<p>54 m<sup>2</sup></p> <p>1.0 m</p> <p>54 m<sup>3</sup></p>

### Performance

No data were provided on the quality or quantity of the burning area storm water so specific loading reductions cannot be calculated.

### Costs

The estimated capital cost for the proposed system, presented in Table 5, was determined using in-house information.

The operating costs include the cost for transferring the accumulated storm water from the sump to the onsite evaporation pond. This amounts to approximately \$1,000 (\$1991) each year for the required labour, based on the assumption that ETI already has vacuum trucks, and that the storm water would required transfer approximately once every five days.

Since the quality of the storm water collected from the burning pad is unknown, the sludge removal requirements from the evaporation pond can not be determined.

## **5.0      SUMMARY OF BAT OPTIONS**

Table 6 presents a summary of costs and performance of the BAT Options recommended for ETI.

**Table 5**  
**Estimated Capital Cost of Bermed Burning Area for ETI**

Component	Cost (\$1991)
<b>Burning Pad</b> <ul style="list-style-type: none"> <li>(includes reinforced concrete, excavation, fire bricks, immobilization, insurance/bonding and landscaping)</li> </ul>	33,600
<b>Storm Water Collection Sump</b> <ul style="list-style-type: none"> <li>(includes concrete, excavation, insulation, immobilization, insurance/bonding, landscaping and connecting drain)</li> </ul>	1,056
<b>Evaporation Pond</b> <ul style="list-style-type: none"> <li>(includes excavation, clearing/grubbing, clay lining, rip-rap, geotextile, berms, immobilization, landscaping, insurance/bonding)</li> </ul>	49,500
<b>Total</b> <ul style="list-style-type: none"> <li>(includes 35% installation, 30% estimating contingency, 15% engineering and 7% G.S.T., ENR CCT<sup>3</sup> 6343)</li> </ul>	162,000

**Table 6**  
**Summary of Cost and Performance of BAT Options for ETI**

Component	Estimated Result	
	BAT Options 1, 2 and 3	BAT Options 4 and 5
<b>Cost</b> <ul style="list-style-type: none"> <li>Capital (\$1991)<sup>1</sup></li> <li>Operating (\$1991)<sup>1</sup></li> </ul>	0 0	162,000 1,000
<b>Performance</b>	No change	Unknown <sup>2</sup>
<b>Notes:</b> 1. Based on ENR CCI 6343 <sup>3</sup> . 2. Storm water from burning area and/or once through cooling water not sampled directly in MISA Monitoring Regulation program.		

## 6.0 OTHER WATER MANAGEMENT ISSUES

Process wastewater is currently discharged into an unlined evaporation pond of native materials, without berms. The pond may contain a large variety of contaminants used in the production of water gel explosives as presented in Table 7.

<sup>3</sup> Engineering News Record Construction Cost Index.

<p align="center"><b>Table 7</b>  <b>Possible Contaminants in the ETI Evaporation Pond</b></p>	
<p align="center"><b>Water Gel Explosives Ingredients</b></p>	
<ul style="list-style-type: none"> <li>• monomethylamine</li> <li>• monomethylamine nitrate</li> <li>• ammonium nitrate</li> <li>• sodium nitrate</li> <li>• calcium nitrate</li> <li>• aluminum</li> <li>• guar</li> <li>• perlite</li> <li>• rubber</li> <li>• glass/ceramic bubbles</li> </ul>	<ul style="list-style-type: none"> <li>• starch</li> <li>• iron oxide</li> <li>• glycol</li> <li>• fumaric acid</li> <li>• Tyzor<sup>TM</sup></li> <li>• DW-3<sup>TM</sup></li> <li>• Dextrine<sup>TM</sup></li> <li>• Bardac<sup>TM</sup></li> <li>• Dayglo<sup>TM</sup></li> <li>• Percol<sup>TM</sup></li> </ul>

The risk of environmental contamination cannot be defined without groundwater or soil contamination testing. A comprehensive study of groundwater and soil contamination would involve sampling and analysis sufficient to assess the entire pond area as well as the contaminants of concern. Typically, such a study would cost approximately \$50,000. The current accepted practice for wastewater pond systems incorporate virtually impermeable pond linings, as well as berms, to protect the surrounding environment from the pond contents (Ref. 5). Lining and provision of berms on the existing pond at ETI should be included in a comprehensive wastewater management plan for the site.

## 7.0 REFERENCES

1. Inorganic Chemical Manufacturing Sector Plants, Site Visit Report, Explosives Technologies International (ETI) Canada Ltd. April 2, 1991 (unpublished).
2. Inorganic Chemical Sector Global Study, Site Visit Information Report, Explosives Technology International.
3. General Technology Report, Oil and Grease Removal by Absorption.
4. General Technology Report, Sedimentation for Suspended Solids Removal.
5. General Technology Report, Pond Liners.
6. Telephone conversation with Marcel Parreault of Explosives Technologies International (Canada) Ltd. October 1991.
7. Sister Plant Technology Report, Coagulation/Settling/Filtration Ponds at Cabot Canada Ltd.

8. *Industrial Wastewater Treatment Technologies*. Patterson, James W. Butterworth-Heinemann, 1985.





## **APPENDIX**

### **Figure and Tables**



Table A1, EXPLOSIVES TECHNOLOGIES INTERNATIONAL  
Summary of Priority One Pollutants, Flow data and Toxicity Data

MISA Control Point, OT0100

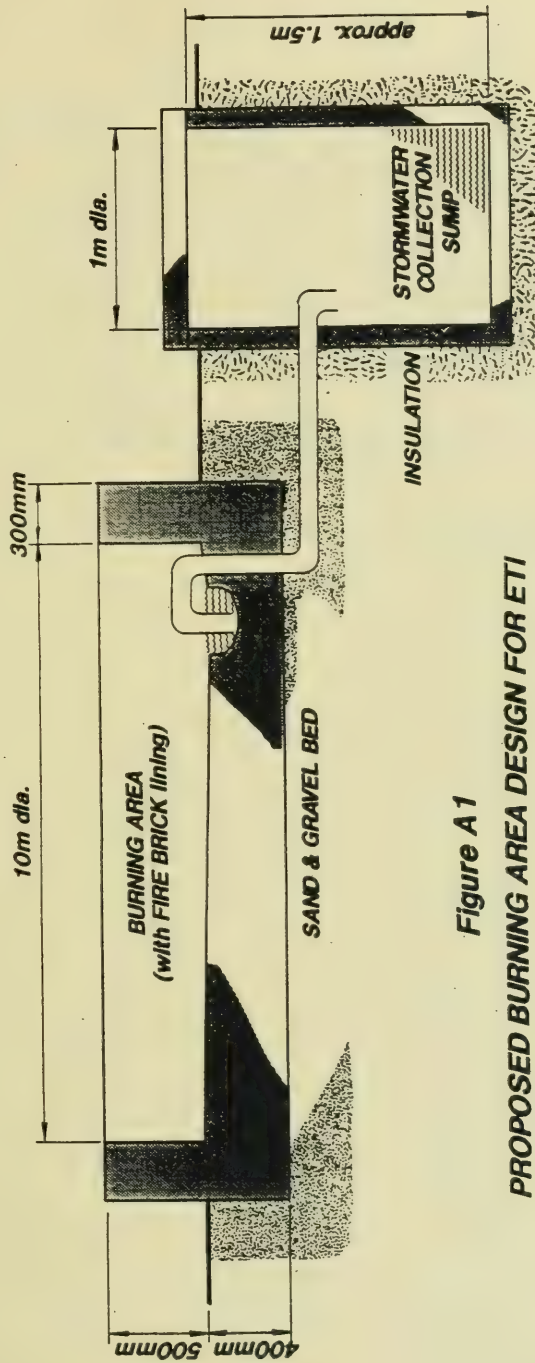
Description: Once through non-contact

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	194	2160	885	
Total Suspended Solids	mg/L	4.2	33	11.8	13.5
Specific Conductance	uS/cm	130	670	274	
DOC	mg/L	4.6	11	6.76	5.46
TOC	mg/L	5	8.4	6.73	8.66
Oil and Grease	mg/L	0.96	4.5	1.49	1.28
Ammonia plus Ammonium	mg/L	0.028	10.6	4.16	4.75
Nitrate and Nitrite	mg/L	1.27	53	9.91	13.6
Total Kjeldahl Nitrogen	mg/L	0.2	8.5	5.18	4.43
Total Phosphorus	mg/L	0.69	0.63	0.162	0.116
Aluminum	ug/L	160	4600	1320	1.2
Strontium	ug/L	36	70	54.5	0.048
Zinc	ug/L	4	110	36.8	0.042

**Table A2**  
**Summary of Acute Lethality Data Covering from Dec 1989 to May 1990**  
**for Explosives Technologies International (ETI)**

Test Species	Number of Samples	Range of Data	Number of Non-Lethal Samples
Rainbow trout	2	all non-lethal	2
<u>Daphnia magna</u>	2	> 100 % to non-lethal	1





**Figure A1**  
**PROPOSED BURNING AREA DESIGN FOR ETI**

# ETI

## North Bay

ATG	PARAMETER	CONCENTRATIONS			LOADINGS kg/d
		RMDL	UNIT	OT 0100	OT 0100
c	Total suspended solids	5	mg/L	11.8	13.5
c	Hydrogen ion (pH)			7.29	
c	Specific conductance		uS/cm	274	
c	DOC	0.5	mg/L	6.76	5.46
c	TOC	5	mg/L	6.73	8.66
c	Oil and grease	1	mg/L	1.49	1.28
c	Ammonia plus Ammonium	0.25	mg/L	4.46	3.87
c	Nitrate + Nitrite	0.25	mg/L	9.38	10.4
c	Total Kjeldahl nitrogen	0.5	mg/L	5.18	4.43
c	Total phosphorus	0.1	mg/L	0.162	0.117
09	Aluminum	30	ug/L	1320	1.2
09	Strontium	20	ug/L	54.5	0.048
09	Zinc	10	ug/L	36.8	0.042
98	Ftflow		m3/d	865	

Notes:

OT0100 is the effluent stream "Discharge at Weir" and this flows to Lake Nipissing.

**APPENDIX 9**  
**Exolon ESK Company of Canada Ltd.**



# **ONTARIO INORGANIC CHEMICAL SECTOR PLANTS REPORT ON BAT OPTIONS EXOLON ESK COMPANY OF CANADA LTD.**

## **1.0 PLANT DESCRIPTION**

Exolon ESK, in Thorold, produces fused aluminum oxide abrasives. Molten aluminum oxide is formed in an electric arc furnace through the melting of bauxite, coke and iron borings. The molten product is poured, cooled and solidified prior to crushing, grinding and the size classification required for sale of the product. By-product ferro-silicon is periodically poured from the furnace and is also solidified, crushed and sold when markets exist.

The process involves contact cooling water which is drawn from an unused section of the Welland Canal known as the Third Welland Canal Raceway.

Details on plant production processes and wastewater management are provided in the site visit report (Ref. 1).

## **2.0 WASTEWATER SOURCES AND QUALITY**

### **2.1 Wastewater Sources**

Contact cooling water is the only process effluent generated in the production of aluminum oxide abrasives at this plant. Non-process related effluents consist entirely of storm water collected from the plant site.

Contact cooling water is combined with some of the storm water flows from the plant site prior to passing through a compartmentalized concrete settling basin. The remainder of storm water flows combine with the discharge from this settling basin. This combined stream was monitored during the MISA Monitoring Regulation as Control Point CO0100. No other monitoring of storm water or intake water was conducted.

### **2.2 Wastewater Flows and Quality**

Table A1 in the Appendix presents average, maximum and minimum flow and concentration data as well as average daily loadings for those contaminants defined by the Ministry of the Environment as "Priority 1" for MISA Control Point CO0100.



### 3.0

### RATIONAL FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for wastewater management, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

#### BAT Option 1

Toxicity data collected and compiled for the first six months of the MISA monitoring period by the Ministry of the Environment are presented in Table A2. Six tests on rainbow trout and Daphnia magna were carried out on samples collected at MISA Control Point CO0100. In five of six tests on rainbow trout and four of six tests on

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Daphnia magna, no deaths occurred. The lethal concentrations ranged from >100% to non-lethal.

These toxicity results indicate that effluent at CO0100 is non-lethal to the test species in a large majority of cases. Therefore, no change to the existing system is recommended for BAT Option 1. There is insufficient information to evaluate the cause of the three lethal results. Further testing to confirm toxicity, and if required, a toxicity reduction study, would be recommended to achieve non-lethality on a continuing basis.

### **BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), BAT, BPT and effluent limitations were not defined for the abrasives manufacturing sub-category. Furthermore, a search for "sister" abrasives plants in the U.S. found that technologies for wastewater control more advanced than those existing in Ontario were not used (Ref. 2). Thus, a BAT Option 2 was not defined.

### **BAT Option 3**

Four abrasives manufacturing plants are included in the Ontario Inorganic Chemical Sector. All of these plants incorporate settling and recycle of contact cooling water with discharge of overflows. Table 1 presents a comparison of major process related contaminants discharged from the four plants. Exolon's effluent compares favourably to other abrasives plants, especially with regard to oil and grease, which was not detected frequently enough to be considered a "Priority 1" parameter.

Since more advanced technologies are not being used for wastewater control at any Ontario plant, BAT Option 3 is the existing wastewater system at Exolon ESK.

### **BAT Option 4**

Careful review of the process and quality of effluents (Table A1) at the plant indicated that a number of contaminants including DOC, TOC, total phosphorus, aluminum, copper, strontium, chloride and sulphate are present at levels which are consistent with surface water quality in Ontario. Technologies for the removal of these low levels of contaminants may be available and have been used in specific applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations.

**Table 1**  
**Comparison of Effluents from Four Ontario Abrasives Plants <sup>1,2</sup>**

Parameter	Exlon ESK Company of Canada Ltd. <sup>3</sup>	Norton Advanced Ceramics of Canada Inc. <sup>4</sup>	Washington Mills Ltd. <sup>5</sup>	Washington Mills Electro-Minerals Corp. <sup>6</sup>
Flow (m <sup>3</sup> /d)	9,440	7,430	1,988	17,810
TSS mg/L	19	17	20	5.2
kg/d	185	123	41	94
Aluminum µg/L	280	1,433	68	159
kg/d	2.7	10.7	0.14	2.8
Oil & Grease mg/L	n.p. <sup>7</sup>	1.5	6.1	1.2
kg/d	n.p. <sup>7</sup>	11.5	12.2	20.7
Notes:				
1. Average flows and loadings, and mean concentrations measured over 12 months of MISA Monitoring Regulation period.				
2. Contaminant loads are not directly comparable and should be based on production rates. Production rates were unavailable for most plants.				
3. Measured at Control Point CO0100 at Exlon ESK.				
4. Measured at Control Point CO0200, CO0300 and CO0400 at Norton.				
5. Measured at Control Point CO0100 at Washington Mills Ltd.				
6. Measured at Control Point CO0100 and CO0200 at Washington Mills Electro-Minerals.				
7. Oil and grease not a "Priority 1" parameter at Exlon ESK.				

Total suspended solids levels average 19 mg/L with a peak of 122 mg/L (Table A1). The source of these solids is not clear since data on intake water quality were not available and since settling basin effluent is combined with untreated storm water prior to MISA Control Point CO0100 and discharge.

Two factors support the contention that these solids do not have their source in the process. Firstly, all process wastewater (i.e. contact cooling water) is treated in the settling basin and a substantial amount of material consisting largely of bauxite, is recovered for reuse. These solids appear to be readily settled in the existing settling basin. Secondly, aluminum levels in the effluent are low, averaging 280 µg/L, suggesting that the TSS present is not made up of process raw materials or products.

Further study may be required to confirm that the existing settling basin is functioning adequately. This would require data on the flowrate and TSS levels leaving the settling basin. However, flow and concentration data at CO0100 include untreated storm water flows. Therefore it is not possible to confirm whether surface and weir loading rates are within normal operating ranges for primary settling units.

A Storm Water Management Study may also be required to confirm whether untreated storm water is contributing significantly to solids loadings, and to identify how such a sources may be controlled. Since some storm water passes through the settling basin, storm water source control may also improve performance of the settling basin.

Total suspended solids data for the intake water should also be collected to assess whether this source contributes significantly to effluent loadings.

The only remaining contaminant of potential concern in Exolon ESK effluent is sulphide, which averaged 43 µg/L during the MISA monitoring period, with a maximum reading of 60 µg/L. The exact source of this contaminant is unknown, but possibilities include:

- Release of by-product sulphide from silicon carbide manufacturing activities now permanently shut-down.
- Storm water contamination from onsite coke storage.

Since process-related sulphides are not a problem at the remaining aluminum oxide operations in Ontario, it would seem unlikely that these operations at Exolon ESK are contributing to sulphides loadings. Therefore, BAT Option 4 does not include measures for reduction of sulphide loadings.

### **BAT Option 5**

Technologies that would advance the plant further towards zero-discharge of pollutants were not identified in the global search.

The plant already recycles cooling and storm water from the settling basins, to minimize the amount of intake water required and effluents discharged. However, the rate of recycle is dependent on the temperature required for cooling. Further increase of these rates would only be possible with expanded equalization ponds, to allow for greater heat transfer, or more elaborate air cooled or refrigerated systems. None of these systems are considered practical due to the very large capital expenditures, and expansive land area or electricity requirements. Therefore, these approaches to cooling are not recommended.

Zero-discharge of contaminants associated with contact cooling water would result if cooling water were non-contact, as would be the case if, for example, furnace cooling jackets were used. Reports from the abrasives industry (Ref. 3) indicate that this is not a feasible approach. In aluminum oxide abrasives manufacturing, by-product ferro-silicon and other impurities collect in the bottom of the furnace. Periodically, this material is super-heated and poured out of the furnace. This procedure requires considerably more heat than for melting aluminum oxide, and results in substantial damage to the furnace refractory lining (usually bricks). The cooling method currently used,



involving cascading water, is considered the only way to prevent major accidents in these instances. A water cooled jacket, for example, would be severely damaged and would not function adequately under these circumstances.

Based on the above discussion, BAT Option 5 is the same as BAT Option 4, since feasible technologies that would advance the plant further towards zero-discharge were not identified.

## Summary

Table 2 presents a summary of BAT Options defined for Exolon ESK.

<p style="text-align: center;"><b>Table 2</b> <b>Summary of BAT Options for Exolon ESK</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	<ul style="list-style-type: none"> <li>• No changes to existing system.</li> <li>• Further toxicity testing and possible toxicity reduction study.</li> </ul>
2	U.S. BAT	<ul style="list-style-type: none"> <li>• No option defined.</li> </ul>
3	Best demonstrated in Ontario	<ul style="list-style-type: none"> <li>• No changes to existing system.</li> </ul>
4	Maximum reduction of pollutants	<ul style="list-style-type: none"> <li>• No changes to existing system.</li> <li>• Performance and operation assessment of existing settling basin, including intake water monitoring.</li> <li>• Sulphide source study and control.</li> </ul>
5	Furthest toward zero-discharge of pollutants	<ul style="list-style-type: none"> <li>• Same as BAT Option 4.</li> </ul>

## **4.0      INFORMATION SOURCES**

1. Inorganic Chemical Manufacturing Sector Plants, Site Visit Report, Exolon ESK Company of Canada Ltd. March 22, 1991 (unpublished).
2. Telephone contacts made to U.S. abrasives manufacturing facilities:
  - George Tasevski of Exolon-ESK in Buffalo, New York. August 1991.
  - Mark Rollins of Norton Company in Worcester, Massachusetts. August 1991.
  - Dean Venturine of Washington Mills, Niagara Falls, New York. August 1991.

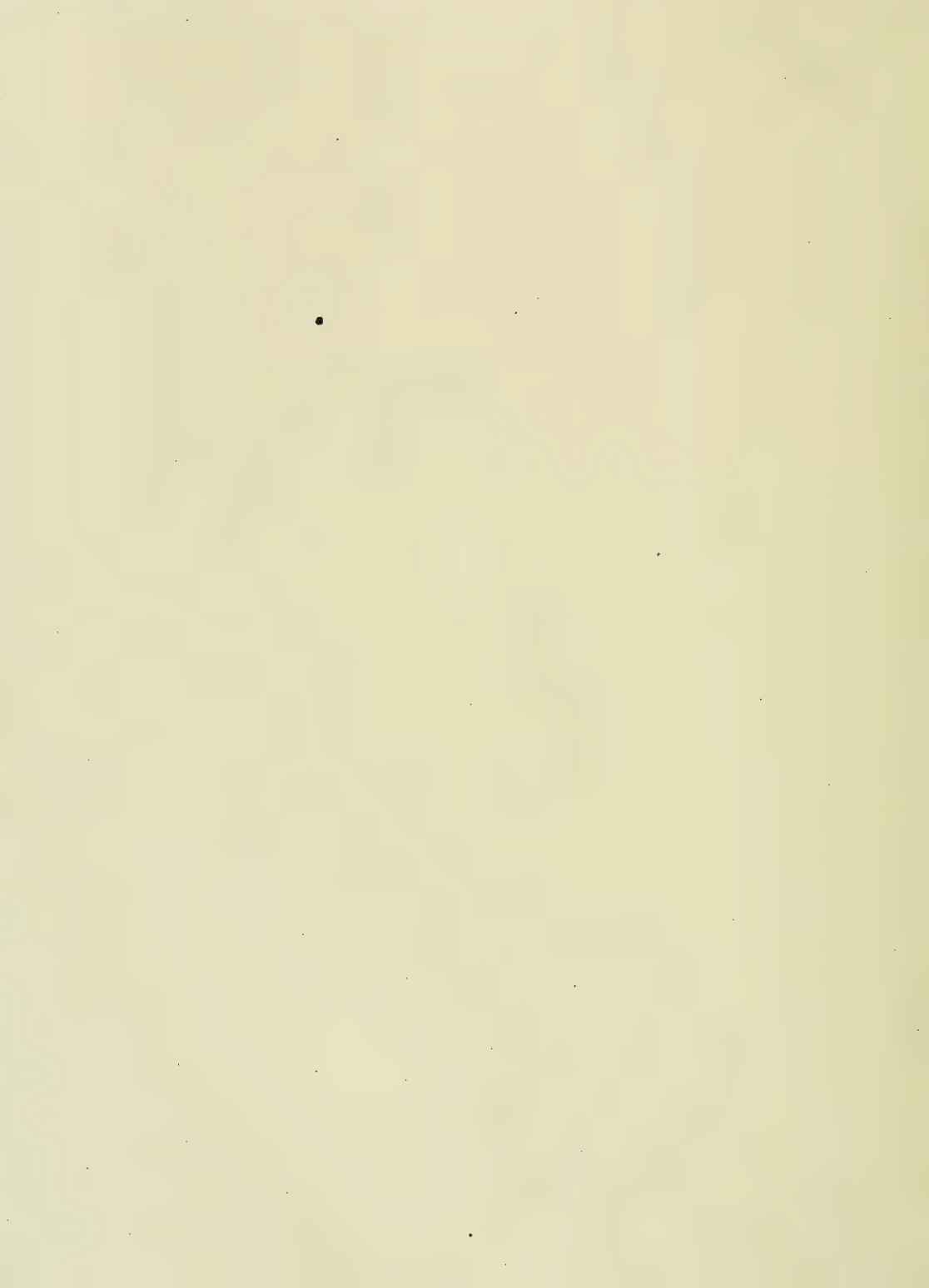


3. Telephone conversation with Rick Chambers of Norton Advanced Ceramics, Inc., July 1991.



## **APPENDIX**

### **Figures and Tables**



**Table A1, Exolon Esk Company of Canada Ltd., Thorold Plant**

Summary of Flow and Priority One Pollutants

MISA Control Point: CO0100

Description: Beaver Dam Road

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	2981	14562	9439.925	
DOC	mg/L	0.35	27	3.3	33.246
TOC	mg/L	1	28	4	40.988
Total Phosphorus	mg/L	0.069		0.137	1.386
Specific Conductance	uS/cm	275	408	305	
Total Suspended Solids	mg/L	2.5	22	19	184.724
Aluminum	ug/L		720	280	2.694
Copper	ug/L	1	32	9	0.088
Strontium	ug/L	81	180	142	1.392
Sulphide	ug/L	26	60	43	0.411
Chloride, Unfiltered Reactive	mg/L	17	19	18	174.204
Sulphate, Unfiltered Reactive	mg/L	29	32	30.5	295.251



**Table A2**  
**Toxicity Data for Exolon ESK for the First Six Months**  
**of MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-Lethal Samples
Rainbow Trout	6	>100% to non-lethal	5
Daphnia magna	6	>100% to non-lethal	4

**Exolon – Esk  
Thorold**

		CONCENTRATIONS		LOADS kg/d	
ATG	PARAMETER	RMDL	UNIT	CO 0100	CO 0100
c	Total suspended solids	5	mg/L	19	184
c	Hydrogen ion (pH)			8.31	
c	Specific conductance		uS/cm	303	
c	DOC	0.5	mg/L	3.3	33.2
c	TOC	5	mg/L	4.03	41
c	Oil and grease	1	mg/L	1.07	10.1
c	Ammonia plus Ammonium	0.25	mg/L	0.08	0.762
c	Nitrate + Nitrite	0.25	mg/L	0.187	1.76
c	Total Kjeldahl nitrogen	0.5	mg/L	0.25	2.44
c	Total phosphorus	0.1	mg/L	0.137	1.39
09	Aluminum	30	ug/L	284	2.74
09	Copper	10	ug/L	9.39	0.093
09	Strontium	20	ug/L	156	1.5
14	Phenolics (4AAP)	2	ug/L	2	0.019
15	Sulphide	20	ug/L	55	0.531
17	Benzene	0.5	ug/L	0.485	0.005
17	Toluene	0.5	ug/L	1.55	0.016
2	Cyanide Total	0.005	mg/L	0.004	0.038
98	Ftflow		m3/d	9550	
11	Chloride	2	mg/L	18	174
12	Fluoride	0.1	mg/L	0.15	1.47
13	Sulphate	5	mg/L	30.5	295

**Notes:**

CO0100 is the effluent stream " 24" Outfall at Beaver – dam Road".  
This stream flows to Lake Gibson and then to Lake Ontario.



## **APPENDIX 10**

**General Chemical Canada Ltd.**





# ONTARIO INORGANIC CHEMICAL SECTOR

## REPORT ON BAT OPTIONS

### GENERAL CHEMICAL CANADA LTD.

#### 1.0 PLANT DESCRIPTION

General Chemical Canada Ltd., in Amherstburg, Ontario manufactures soda ash (sodium carbonate) and calcium chloride from natural formation sodium chloride (salt) brine and calcium carbonate (limestone). Soda ash is produced in the Solvay process, where purified brine is ammoniated, and carbonated to form sodium bicarbonate crystals, which are filtered and dried to form the sodium carbonate product. The Solvay process yields a calcium chloride solution by-product, which is carbonated to remove excess lime, chlorinated to oxidize sulphite to sulphate, evaporated in a three stage evaporation process, and centrifuged to remove crystallized impurities. The strong (40%) calcium chloride filtrate from the centrifuge is either sold as product, or further dried and flaked.

Water from the Detroit River is used at the plant primarily as barometric condenser (contact) cooling water, once through non-contact cooling water and air scrubber water. There are other miscellaneous smaller uses such as wash water.

Details on the plant processes, water uses and wastewater management are presented in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Wastewater Sources

MISA Control Point CO0100, which discharges at an average rate of 15,000 m<sup>3</sup>/d, includes primarily wastewater from the final effluent settling lagoon, referred to as the soda ash settling basin (SASB), in addition to storm water from both General Chemical and Allied Chemicals<sup>1</sup> plant areas.

The SASB receives wastewater from the following sources:

- Soda ash process
  - process pump seal water
  - compressor lubricating water

---

<sup>1</sup>

Allied Chemicals Canada Inc., which produces hydrofluoric acid and chlorofluorocarbons, is located on the same site (Ref. 2).

- rail car wash water
  - distiller once through non-contact cooling water
  - process area spills and wash water
  - dryer wash water.
- Calcium chloride process
    - primary settler sludge
    - slurried salt from the centrifuge
    - brine mud treatment tank overflow
    - process area wash water
    - dryer contact spray scrub water
    - secondary settler sludge
    - process pump gland water
    - milk of lime tank building trench flushings and wash water.
  - Boiler house
    - water filter backwash water
    - sedimentation tank sludge.
  - Allied Chemicals Canada Inc. (Ref. 2)
    - hydrofluoric acid settling pond overflows
    - Genetron process effluents.

MISA Control Point CO0200, referred to as the Main Drain, monitored flows from the following sources:

- Spent carbon dioxide scrubber water and non-contact cooling water from the soda ash process.
- Barometric condenser contact cooling water, and once through non-contact cooling water from the calcium chloride process.
- Boiler blowdown.
- Storm water.

## 2.2 Wastewater Flows and Quality

Tables A1 and A2 in the Appendix present mean, maximum and minimum data for flows and those contaminants defined as Priority 1 by the Ministry of the Environment,

at MISA Control Points CO0100 and CO0200. Table A3 presents intake water quality data from the 12 months of MISA monitoring.

### 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>2</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following subsections.

A global search was carried out to identify technologies used for pollution reduction in the manufacturing of soda ash using the solvay process. No Solvay processes other than General Chemical are operating in the U.S. or Canada, and most of the world's Solvay plants are in Europe (Ref. 3). Many of these discharge to salt water bodies.

---

<sup>2</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Only limited information could be obtained from a large European company with Solvay plants in several countries. Information provided indicated that little treatment beyond TSS removal and flow control are practised at Solvay plants. Effluent limits cover pH, temperature, TSS, total nitrogen and chloride. Limits provided for three European plants are compared to General Chemical's effluents in Table 1. With the exception of pH, General Chemical is discharging a quality of effluent that exceeded requirements prescribed by European limits. European effluent limits for pH, however, are based on final effluent discharge streams which have cooling water and process effluent streams combined. This is not the case for General Chemical, and data presented by the company indicates that pH values would meet European limit values if their two effluent streams were combined before final discharge.

<b>Table 1</b> <b>Comparison of General Chemical Effluent Quality to Effluent Limits at European Solvay Plants</b>				
Parameter	General Chemical Effluent Quality <sup>1</sup>	Effluent Limits <sup>2</sup>		
		Belgium	France	Germany
pH	10.9-11.1 (CO0100) 7.5-8.9 (CO0200)	6.5-9.5	5.5-9.5	-
Temperature	-	<30 °C	<30 °C	-
TSS • (mg/L)	30	<200	<50	-
Ammonia-N • (mg/L) • (kg/t) <sup>3</sup>	3.2 0.6	<50 -	- -	- 0.9
Total nitrogen • (mg/L)	4.5	-	<30	-
Chloride ions • (mg/L) • (kg/t) <sup>3</sup>	3,960 732	<10,000 -	<250 in river downstream of plant	- 1,200
<b>Notes:</b> 1. Includes average concentrations and total loadings calculated from 12 month means measured at Control Points CO0100 and CO0200. 2. Limits set for specific plant in these countries, discharging to freshwater receiving bodies (Ref. 4). 3. Kilogram per tonne of soda ash produced.				

The information retrieved in the global search indicates that more advanced technologies for reduction of process contaminants, in particular, dissolved solids, are not used at Solvay plants world-wide. Therefore, in order to define BAT Options, technologies



used in other industry sectors used for management of wastewaters similar in quality to those at General Chemical were considered.

### **3.1      BAT Option 1**

Toxicity data collected, compiled and verified by the Ministry of the Environment for the first six months of monitoring are presented in Table A4. Six tests on rainbow trout and six tests on Daphnia magna were carried out on samples from the North Drain (CO0100) and Main Drain (CO0200).

Samples from CO0200 were essentially non-lethal, with only one of six tests resulting in lethal concentrations <100%. Based on these results, no changes to the existing system are recommended for discharges through Control Point CO0200. However, the cause of lethal results for one sample is unknown, and continued sampling followed by a toxicity reduction study, if necessary, are recommended to ensure non-lethality

Lethal concentrations of samples from CO0100 to both of the test species ranged from 19 to 42 percent for rainbow trout, and 6 to 9 percent for Daphnia magna. Although several low levels of contaminants are present in effluents monitored at CO0100, the most obvious source of toxicity is total dissolved solids, including chloride at five percent concentrations. Methods for total dissolved solids reduction in wastewater include deep well injection and treatment for total dissolved solids removal. The feasibility of deep well injection of the soda settling basin effluents must be based on a detailed review of the geological characteristics of injection area. Since this information is not available, this technology was not considered further under BAT Option 1.

Treatment methods for TDS removal include evaporation, membrane processes, and electrodialysis. Brine concentration, using vapour compression evaporators, has been widely used to concentrate effluents, in the treatment of cooling tower blowdown and other concentrated TDS streams in the electric power generating industry. This process produces a concentrated effluent that can be recovered or disposed, or further concentrated by crystallization or spray drying to produce a solid for disposal. The resulting high quality condensate can be reused in the plant, as boiler make-up, or for other uses, without requiring additional treatment. Brine concentration is recommended under BAT Option 1 to produce a non-lethal discharge from MISA Control Point CO0100.

### **3.2      BAT Option 2**

Under 40 CFR, of the U.S. Federal Register (July 1, 1989 Edition), effluent limits were not defined for soda ash production plants using the Solvay processes. At the time of U.S. BAT limits regulations development in the 1980s, only one plant in the U.S. was producing soda ash using the Solvay process, and it was considered inappropriate to

write regulations for this sub-category (Ref. 5). This plant has since permanently ceased operation. U.S. BAT was not defined for the production of calcium chloride.

A BAT Option 2 is not defined for General Chemical.

### **3.3            BAT Option 3**

BAT Option 3 is defined as the existing process at General Chemical, since no other sodium carbonate or calcium chloride production plants are existing in Ontario.

### **3.4            BAT Option 4**

BAT Option 4 includes technologies that provide the maximum reduction of pollutants from wastewater discharges.

#### **3.4.1        North Drain Effluents CO0100**

Maximum reduction of total dissolved solids from the effluent stream measured at CO0100 will provide a high level of removal of all non-volatile components from the effluents, including:

- nitrate and nitrite
- phosphorus
- TSS
- metals (except mercury)
- extractable trace organics and dioxin.

These contaminants would be transferred to the residual concentrated solids stream.

Removal of these contaminants upstream of the evaporation/drying process, to avoid transfer to the solid waste residual, is not recommended under BAT Option 4 for the following reasons:

- Removal of metals, phosphorus and TSS would produce a residual containing these pollutants that would require disposal. Therefore, there is no advantage to an additional treatment step.
- Extractable trace organics and dioxins are not contaminants that appear to be related to processes at General Chemical. They likely originate from Allied Chemicals. Removal of trace organics and dioxins originating in Allied Chemical's chlorofluorocarbon plant is addressed under BAT Options for Allied Chemicals (Ref. 6).



The evaporation process is recommended for the North Drain effluents monitored at Control Point CO0100, under BAT Option 4. The liquid effluent stream from the process will contain the following contaminants:

- cyanide
- mercury
- volatile organic compounds
- ammonia

The sources of mercury and cyanide in effluents are unknown; however, a review of materials used at General Chemical and Allied Chemicals did not suggest that the plant operation is a source of these contaminants. A pollution prevention approach, involving an audit of pollutant sources and implementation of appropriate sources controls, is recommended for reduction of cyanide and mercury. Since low levels of cyanide and mercury were measured in all effluent streams discharged from General Chemical and Allied Chemicals, it is likely that these pollutants are contributed from storm water, and therefore, the main focus of the audit should be within a Storm Water Control Study. Demonstrated technologies for removal of cyanide and mercury at the dilute concentrations present in General Chemical effluents were not identified in a global search.

The MISA monitoring data from Allied Chemicals effluents, coupled with a knowledge of the General Chemical process, indicates that volatile organics present at MISA Control Point CO0100 were most likely contributed from Allied Chemicals. Methods for the reduction of these pollutants in Allied Chemicals effluent streams are addressed in the Report on BAT Options (Ref. 6), and no recommendations are made with respect to these contaminants in this report.

Ammonia present in effluents is likely originating from the soda ash plant, where ammonia is used to enhance carbonation of pure brine. Ammonia is distilled from the effluent stream, and recycled back to the process. However, trace amounts of ammonia remain in effluents, which ultimately reach the soda ash settling basin after further processing in the calcium chloride plant. The efficiency of the distillation process, and therefore, the treatability of this stream for further ammonia reduction, are unknown. Therefore, in-plant treatment for reducing ammonia levels cannot be identified. Treatment technologies for removal of ammonia at these levels (4 mg/L) identified in a global search include ion exchange and breakpoint chlorination. Because of operating problems associated with each of these processes, neither was recommended for treating this stream at General Chemical. Therefore, no additional processes for ammonia removal are recommended under BAT Option 4.

Based on the above discussion, BAT Option 4 for discharges monitored at MISA Control Point CO0100 includes evaporation of the stream, reuse of the evaporator condensate for supplementing intake water used at the plant, and disposal or sale of concentrated TDS wastes.

The Main Drain effluent is primarily made up of barometric condenser contact cooling water, water treatment residual streams and once through cooling water, in addition to storm water.

Several contaminants in this stream, including TSS, nitrate, TKN, phosphorus, aluminum, copper, strontium, octochlorodibenzo-dioxin, oil and grease, fluoride and sulphate, were not present in effluents at levels significantly different from the intake water concentrations. This indicates that contamination is not introduced in the process.

Technologies for the removal of low levels of contaminants contributed in raw water present in these effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

In addition, low levels of chloride present in effluents at CO0200 were contributed from the plant. However, at the average levels in effluents of 99 mg/L, practical treatment technologies for removal of this contaminant were not identified.

Low levels of cyanide, mercury, sulphide, and furan compounds, present at Control Point CO0200, were also detected at CO0100. Since these compounds do not appear to be process related, one probable source is contaminated storm water runoff from either General Chemical or the Allied Chemicals property. The sources of these contaminants should be investigated as part of a Storm Water Control Study.

Some ammonia in the effluent monitored at CO0200 may be contributed from the barometric condenser stream<sup>3</sup>. However, calculated levels in this stream would average <4 mg/L, and feasible technologies for ammonia removal at these levels were not identified.

Replacing the barometric condenser with a surface contact condenser has been shown to be an effective process for condensing process vapours generated in the manufacture of ammonia (Ref. 7). Rather than producing a large, dilute contaminated stream a non-contact cooling water stream and concentrated residual stream result.

---

<sup>3</sup>

The plant reports that less than 20 percent of the ammonia at CO0200 is actually contributed from the barometric condenser condensate. This information was unavailable at the time of report preparation, and it was assumed that the condensate was the main ammonia source.

Implementation of surface condensers were included in BAT Option 4 to replace General Chemicals barometric condensers. Based on information provided by General Chemical (Ref. 9) and the MISA monitoring data, a 200 m<sup>3</sup>/d condensate stream with a mean ammonia concentration of 299 mg/L will be produced in addition to about 130,000 m<sup>3</sup>/d of once through cooling water. Therefore, ammonia removal would also be required for this stream.

Demonstrated technologies for removal of ammonia at this level include steam stripping and biological nitrogen removal. In this case, steam stripping is the preferred alternative, because the concentrated ammoniated vapours could be condensed and recovered for reuse in the calcium chloride process. Based in information provided in Section 4, greater than 10 mg/L of ammonia would remain in steam stripper effluents.

Technologies have been identified and are available for further reduction of ammonia from this stream. However, if this stream were added to the soda ash settling basin, ammonia levels in basin effluents would not increase significantly. Furthermore, under recommended BAT Option 4, this stream would not be discharged. Thus, rerouting of the treated surface condenser condensate stream to the soda ash settling basin is recommended under BAT Option 4.

### 3.5 BAT Option 5

BAT Option 5 incorporates those technologies that would move the plant furthest toward zero discharge. For this Option, technologies were not identified beyond those presented in Option 4.

TDS removal from effluents measured at CO0100 will produce an high quality effluent that can be used to supplement intake water requirements. Therefore, zero-discharge of this stream will be achieved.

Technologies for the elimination of contact discharges from the barometric condenser which pass through Control Point CO0200 were identified in BAT Option 4. Methods for reducing once through cooling water were not identified. Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool process equipment in all manufacturing sectors. Other cooling methods, such closed-loop air cooled systems, would required very large capital expenditures and land area for expansive heat exchange equipment requirements, and may not be effective in warmer months in Ontario. Thus, this approach to cooling is not recommended. And finally, opportunities for consumption of once through cooling water do not appear to exist at the plant.



### 3.6

### Summary

Table 2 presents a summary of BAT Options recommended for General Chemical Canada Ltd.

<b>Table 2</b> <b>Summary of BAT Options for General Chemical Canada</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	<ul style="list-style-type: none"><li>• TDS removal from CO0100 effluents using multi-effect evaporator.</li><li>• No change to the existing system for CO0200 effluents.</li><li>• Confirmation of non-lethality, and if necessary, a toxicity reduction study at CO0200.</li></ul>
2	U.S. BAT	<ul style="list-style-type: none"><li>• Not defined.</li></ul>
3	Best demonstrated in Ontario	<ul style="list-style-type: none"><li>• No change to existing system.</li></ul>
4	Provides maximum pollution reduction	<ul style="list-style-type: none"><li>• TDS removal from CO0100 effluents using multi-effect evaporator.</li><li>• Replacing barometric condensers with surface condensers.</li><li>• Steam stripping surface condenser condensate stream for ammonia recovery and transferring effluent to soda ash settling basin.</li><li>• Condensing steam stripper vapours for reuse in process.</li></ul>
5	Furthest toward zero-discharges of pollutants	<ul style="list-style-type: none"><li>• Some as BAT Option 4.</li></ul>

## 4.0

### BAT OPTIONS

The projected performance and costs associated with implementation of BAT Options 1, 4 and 5 are presented in the following subsections. A BAT Option 2 was not defined, and BAT Option 3 does not include any changes to the existing system at General Chemical.

### 4.1

#### BAT Option 1

##### Description

BAT Option 1 includes technologies for removal of TDS from effluents monitored at the North Drain, Control Point CO0100, which primarily consist of the soda ash settling basin effluents.

Removal of the total dissolved solids, particularly chloride, from these effluents can be achieved with the implementation of a six effect evaporator (brine concentrator). This technology is described in the General Technology report (Ref. 8). At a conceptual design level, it is believed that this process is capable of achieving a 60 percent TDS concentrated residue stream (Ref. 9). Based on the data presented in Table 3, this

would result in a recovery of 86 percent of the stream volume available for reuse in the plant.

**Table 3**  
**Performance Efficiency Projected for Brine Concentrator**

Parameter	Value
Current concentration measured at CO0100 <sup>1</sup>	2.8% CaCl <sub>2</sub> 3.3% NaCl 1.2% other Cl
Current flow rate <sup>1</sup>	15,000 m <sup>3</sup> /d
Projected concentration of VCE <sup>2</sup> residue stream	60% TDS (including CaCl <sub>2</sub> , NaCl, etc.)
Projected volume of VCE <sup>2</sup> residue stream	1,800 m <sup>3</sup> /d
Projected volume of VCE <sup>2</sup> effluent stream	13,200 m <sup>3</sup> /d
Projected recovery	86%
Quality of residue stream	23% CaCl <sub>2</sub> 28% NaCl 9% other chlorides
Notes:	
1.	Mean 12 month data from MISA Control Point CO0100.
2.	Vapour compression evaporator.

The residue stream would be made up of both calcium chloride and sodium chloride salts. The minimum cost option would involve identification of a market for this residue stream, as is. Alternatively, the stream could be returned to the continuous centrifuge in the calcium chloride process, to remove the sodium chloride and other salt impurities in the manufacture of calcium chloride. In this case, an additional estimated 50 to 80 percent capacity would be required to handle this stream. If this is not currently available, then expansion of the continuous centrifuge, bell settler and product storage lagoons may be required. In addition, markets would need to be identified for the additional 153,000 tonnes (44 percent) of calcium chloride generated annually, compared to current production rates.

If markets are unavailable for the residue stream, then disposal would be required. Because calcium chloride does not crystallize well, crystallization of the stream for further volume reduction is not recommended. Furthermore, spray drying of streams of this volume is not considered economically feasible (Ref. 9). Disposal of the liquid,



concentrated salt stream by liquid waste haulers would be the only alternative. However, because this alternative would incur annual disposal costs exceeding \$230 million<sup>4</sup>, the feasibility of implementing TDS removal is unlikely unless the residual stream can be processed for sale or sold as is.

## Performance

Implementation of TDS on the wastewater stream monitored at MISA Control Point CO0100 will eliminate discharges through this point, since treated effluent will supplement intake water to the plant. Depending on where the water is reused, a portion may be discharged through Control Point CO0200. Table 4 presents the projected performance of selected parameters resulting from implementation of this option.

<b>Table 4</b> <b>Projected Performance Resulting from Implementation of the Brine Concentrator at CO0100<sup>1</sup></b>			
Parameter	Current Quality at CO0100 <sup>1</sup>	Projected Quality at CO0100	Loading Reduction
<b>Flow</b> • (m <sup>3</sup> /d)	15,000	0.0	100%
<b>Cyanide</b> • (kg/d) • (mg/L)	0.103 0.007	0.0 0.0	100%
<b>TSS</b> • (kg/d) • (mg/L)	650 44	0.0 0.0	100%
<b>Strontium</b> • (kg/d) • (µg/L)	79.9 4,910	0.0 0.0	100%
<b>Chloride</b> • (kg/d) • (mg/L)	771,000 50,000	0.0 0.0	100%
<b>Fluoride</b> • (kg/d) • (mg/L)	33.6 2.2	0.0 0.0	100%
<b>Sulphate</b> • (kg/d) • (mg/L)	17,600 1,150	0.0 0.0	100%
<b>Notes:</b> 1. Data presented for selected parameters. 2. Mean data for 12 month MISA monitoring at Control Point CO0100.			

<sup>4</sup> Based on \$350/m<sup>3</sup> disposal costs.

## Costs

Costs were estimated for implementation of the brine concentrator to remove TDS in effluents from CO0100. A marketing evaluation is necessary to determine if markets are available for the evaporator residue stream or the additional quantity of calcium chloride that would be generated by reusing this stream in the process. Thus, costs for these options were not estimated within the scope of this study.

Table 5 presents capital costs and estimated operating costs for implementation of the brine concentrator. The system will cost an estimated \$27 million capital, and \$2.6 million operating annually, excluding residue management.

Table 5 Estimated Costs for Implementation of the Brine Concentrator	
Item	Cost <sup>1</sup>
Capital costs (including equipment 35% installation, 15% engineering, 30% contingency and 7% G.S.T.).	\$27,000,000 <sup>2</sup>
Operating costs <sup>3</sup>	\$2.6 x 10 <sup>6</sup> /y
Notes:	
1. Ref. 8.	
2. ENR CCI 6343.	
3. Operating costs for electricity and steam. Residue recycling, management and disposal not included.	

## 4.2 BAT Option 4 and 5

BAT Options 4 and 5 include TDS removal from effluent discharges monitored at CO0100, as described in Section 4.1.

### 4.2.1 Replacement of Barometric Condensers With Surface Condensers

#### Description

BAT Option 4 includes the replacement four existing barometric condensers with surface condensers in the calcium chloride production area. The information presented in Table 6 on the vapour streams was used to calculate the size requirements of the surface condensers for the purpose of costing.

The surface condensers will require a once through cooling water flow rate of approximately 130,000 m<sup>3</sup>/d. Approximately 2,000 m<sup>3</sup>/d condensate will be produced.

## Performance

By replacing the barometric condensers with surface condensers, once through cooling water will be discharged through Control Point CO0200. Performance for most contaminants cannot be calculated because the amount of contamination contributed from the existing barometric condenser effluent to CO0200 is unknown, and water quality at this point was generally not significantly different from intake water.

<b>Table 6</b> <b>Information on Surface Condensers for General Chemical</b>		
Parameter	Stream A	Stream B
Vapour temperature <sup>1</sup>	60 °C	60 K
Vapour flow rate <sup>1</sup>	36,000 kg/h	45,000 kg/h
Number of surface condensers <sup>1</sup>	2	2
Cooling water temperature change	12 °C	12 °C
Required heat transfer <sup>1</sup>	$9.5 \times 10^7$ kJ/h	$1.2 \times 10^8$ kJ/h
Heat transfer coefficient <sup>2</sup>	1,100 W/m <sup>2</sup> °C	1,100 W/m <sup>2</sup> °C
Surface area of each condenser	410 m <sup>2</sup>	510 m <sup>2</sup>
Notes:  1. Ref. 9 2. Ref. 10		

Assuming all of the ammonia in the monitored stream originated in the evaporated condensate, then this would be concentrated in the condensate stream and eliminated from discharges through CO0200. Table 7 summarizes the projected performance at CO0200.

<b>Table 7</b> <b>Projected Performance Resulting from Installation of Surface Condensers</b>			
Parameter	Current Loading at CO0200	Projected Loading at CO0200	Loading Reduction
Flow rate (m <sup>3</sup> /d)	203,000	181,000 <sup>1</sup>	11%
Ammonia (kg/d)	584	0.0 <sup>2</sup>	100%
TKN (kg/d)	648	64.0	90%
Notes:  1. Based on current barometric condenser flow rate of 150,000 m <sup>3</sup> /d, projected once through cooling water discharge rate of 130,000 m <sup>3</sup> /d and projected 2,000 m <sup>3</sup> /d of condensate not discharged through CO0200. 2. Assumes condensate is not discharged through CO0200.			

## Costs

The capital cost, based on information in Ref. 11 and Ref. 12 for all four surface condensers will be approximately \$1,700,000 (ENR CCI 6343). This cost includes 35 percent installation, 30 percent contingency allowance, 15 percent engineering and 7 percent G.S.T. Annual operating costs are not projected to increase.

### **4.2.3      Steam Stripping of Condensate Stream**

#### **Description**

For the purposes of costing, the steam stripper and vapour condenser system presented in the general technology reports (Ref. 12, 13 and 14) were used. The stripper would treat the surface condenser condensate stream generated at a rate of 2,000 m<sup>3</sup>/d with a mean ammonia nitrogen concentration of 299 mg/L. A tube and shell condenser unit would be used to condense the ammonia rich steam, and would use once through cooling that would be discharged through Control Point CO0200. It is assumed that this concentrated ammonia condensate can be returned for use in the process.

Rather than implement additional treatment to further reduce ammonia levels in steam stripper effluents, this effluent can be transferred to the soda ash settling basin. Effluents from the soda ash settling basin (CO0100) will be treated for TDS removal and reused in the plant. Since ammonia will not be removed in the TDS removal system, it will also be present in water reused in the plant. However, because ammonia levels will not increase significantly with the addition of the steam stripper effluent, and natural removal of this non-persistent chemical will occur through volatilization from the settling basin and natural biodegradation, the impacts on the quality of water available for in-plant reuse should be minimal.

#### **Performance**

An average ammonia nitrogen removal efficiency from the surface condenser stream of 95 percent is estimated. This would result in an effluent ammonia nitrogen concentration of 14.6 mg/L, and loading of 29.2 kg/d.

When routed to the soda ash settling basin, the steam stripper effluent would increase ammonia effluent concentrations at Control Point CO0100 to 6.4 mg/L from 5.4 mg/L reported for the 12 month MISA monitoring period. Flow at Control Point CO0100 will increase to 17,000 m<sup>3</sup>/d from 15,000 m<sup>3</sup>/d.

In addition, an estimated 20,000 m<sup>3</sup>/d will be used as once through cooling water to cool the surface condenser used to condense concentrated ammonia vapours. This stream would be discharged to Control Point CO0200.



## Costs

Estimated capital and operating costs for the steam stripper, stream condenser and effluent pipeline to the soda ash settling basin are presented in Table 8.

<b>Table 8</b> <b>Costs of Steam Stripper and Ammonia Vapour Condenser for Surface Condenser Effluent</b>	
<b>Item</b>	<b>Costs</b>
Capital <sup>1</sup>	
• Steam stripper (Ref. 14)	\$2,800,000
• Surface condenser (Ref. 12)	\$670,000
• Pipeline to soda ash settling basin	\$ 25,000
• Total	\$3,495,000
Operating costs (Ref. 15)	\$3,400,000
Notes:	
1. Includes 35% installation, 30% contingency, 15% engineering and 7% G.S.T (ENR CCI 6343).	

### **4.2.4      Summary**

Table 9 summarizes the costs and performance projected for the implementation of BAT Options 4 and 5.

## **5.0      SUMMARY OF BAT OPTIONS**

Table 10 presents a summary of costs and performance resulting from the implementation of BAT Options recommended for General Chemical Canada Ltd.

## **6.0      REFERENCES**

1. Inorganic Chemical Sector Site Visit Report General Chemical Canada Ltd. April 18, 1991. (unpublished).
2. Inorganic Chemical Sector Site Visit Report Allied Chemical Canada Ltd. April 15, 1991. (unpublished).
3. J.D., Adhia. Soda Ash Industry - A World View, Chemical Age India, Volume 37, No. 3, March 1986.



4. Telephone conversations and correspondence with Dr. Kogelnig of Solvay S.A. head office in Brussels, Belgium . August and September, 1991.
5. Development Document for Effluent Limitations Guidelines and Standards for the Inorganic Chemicals Manufacturing Sector Point Source Category. U.S. Report EPA 400/1-79/007. June 1980.

**Table 9**  
**Summary of Cost and Performance of BAT Options 4 and 5**

Technology	Cost	Parameter	Current Loading (kg/d)	Projected Loading (kg/d)	Loading Reduction (kg/d)
TDS removal using brine concentration of stream CO0100.	\$29,000,000 <sup>1</sup> capital	Flow (m <sup>3</sup> /d)	17,000 <sup>1</sup>	0.0	100%
		Cyanide	0.103	0.0	100%
	\$2,800,000 <sup>1</sup> /y operating	TSS	650	0.0	100%
		Strontium	79.9	0.0	100%
		Chloride	771,000	0.0	100%
		Fluoride	33.6	0.0	100%
		Sulphate	17,600	0.0	100%
		Ammonia-N <sup>2</sup>	86.1	109.3	-36%
Replacing barometric condenser with surface condensers, steam stripping of condensate, and condensation and reuse of ammonia rich condensate in process. Transfer of steam stripper effluent to soda ash settling basin.	\$5,195,000 capital	Flow (m <sup>3</sup> /d at CO0200)	203,000	203,000	0%
	\$3,400,000/y operating	Ammonia	584	0.0	100%
		TKN	648	64.0	90%
<b>Total</b>	> \$34,195,000 capital				
	> \$6,200,000/y operating				
Notes:					
1. Includes capacity requirements for additional 2,000 m <sup>3</sup> /d of flow from the steam stripper.					
2. Ammonia levels would increase from steam stripper effluents. However, this stream would not be discharged directly.					

6. Ontario Inorganic Chemical Sector Plant Report on BAT Options Allied Chemical Canada Ltd.
7. Plant Specific Technology Report Surface Condenser for Ammonia Steam Condensation.
8. General Technology Report on Vapour Compression Evaporation for TDS Removal.

9. Information provided by Lonnie Leciw from General Chemical, December 1991.
10. Heat Transfer. J.P. Holman. McGraw-Hill Inc., 1981.
11. Chemical Engineers Handbook, Fifth Edition. R.H. Perry and G.M. Chilton, (eds.). McGraw Hill Inc., 1973.
12. Plant Specific Technology Report Surface Condenser for Ammonia Steam Condensation.
13. General Technology Report Ammonia Removal by Steam Stripping for ICI Nitrogen Products.
14. General Technology Report Ammonia Removal by Steam Stripping for Nitrochem Inc.
15. Industrial Wastewater Treatment Technology, Second Edition. Butterworth Heinmann.

<p align="center"><b>Table 10</b>  <b>Summary of Costs and Performance of BAT Options for General Chemical Canada<sup>1</sup></b></p>			
Component	BAT Option 1	BAT Option 3	BAT Option 4 and 5
<b>Cost</b>			
• Capital	\$27,000,000	\$0	>\$34,195,000
• Operating	\$233,000,000	\$0/y	>\$6,200,000/y
Performance	Loading Reduction		
<b>Control Point CO0100</b>			
• Flow (m <sup>3</sup> /d)	15,000	0	17,000
• Cyanide (kg/d)	0.103	0	0.103
• TSS (kg/d)	650	0	650
• Strontium (kg/d)	79.9	0	79.9
• Chloride (kg/d)	771,000	0	771,000
• Fluoride (kg/d)	33.6	0	33.6
• Sulphate (kg/d)	17,600	0	17,600
<b>Control Point CO0200</b>			
• Ammonia-N (kg/d)	0	0	584
• TKN (kg/d)	0	0	584

## **APPENDIX**

### **Tables**



**Table A1, General Chemical Canada Ltd., Amherstberg Plant**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: North Drain

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m <sup>3</sup> /d	6030	24800	15000	
COD	mg/L	100	400	250	5070
Cyanide Total	mg/L	0.005	0.023	0.007	0.103
Hydrogen Ion (pH)		10.9	11.8	11.5	
Ammonia Plus Ammonium	mg/L	0.1	52.7	5.4	80.1
Total Kjeldahl Nitrogen	mg/L	0.8	10.7	5.9	90
Nitrate and Nitrite	mg/L	0.08	2.47	0.83	13.2
DOC	mg/L	10	1110	221	3530
TOC	mg/L	10	1550	321	5080
Total Phosphorus	mg/L	0.1	2.93	0.24	3.42
Specific Conductance	uS/cm	39300	122000	58700	
Total Suspended Solids	mg/L	3	341	44	650
Aluminum	ug/L	30	340	168	2.81
Boron	ug/L	338	1140	509	8.19
Cadmium	ug/L	0.2	100	1.3	0.23
Cobalt	ug/L	20	1000	114	2.33
Molybdenum	ug/L	20	1000	67	3.22
Nickel	ug/L	10	500	69	1.38
Lead	ug/L	30	1500	232	4.44
Strontium	ug/L	3840	6640	4910	79.9
Thallium	ug/L	30	250	53	0.818
Zinc	ug/L	10	500	55	1.12
Arsenic	ug/L	2	55	19	0.297
Mercury	ug/L	0.1	1.28	0.2	0.003
Phenolics (4AAP)	ug/L	1	5	2.5	0.038
Sulphide	ug/L	10	524	50	0.731
Bromomethane	ug/L	2	10	8.7	0.142
Bromoform	ug/L	2	10	8.7	0.142
Dibromochloromethane	ug/L	1	5	4.3	0.071
Chloromethane	ug/L	2	10	8.7	0.142
Chloroform	ug/L	1	8.1	2.2	0.04
Methylene Chloride	ug/L	1	5	2.9	0.048
Trichlorofluoromethane	ug/L	5	49.3	13.5	0.242
Tetrachloroethylene	ug/L	0.5	2.5	2.2	0.036
Vinyl Chloride	ug/L	2	10	8.9	0.142
1,1-Dichloroethane	ug/L	0.2	1	0.9	0.014
1,1,2-Trichloroethane	ug/L	0.5	2.5	1.3	0.022
1,1,2,2-Tetrachloroethane	ug/L	1	5	4.3	0.071
1,2-Dichloroethane	ug/L	0.2	1	0.9	0.014
1,2-Dichloropropane	ug/L	0.2	1	0.9	0.014



**Table A1, General Chemical Canada Ltd., Amherstberg Plant**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: North Drain

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
cis-1,3-Dichloropropylene	ug/L	0.5	2.5	2.17	0.036
Trans-1,3-Dichloropropylene	ug/L	0.5	2.5	2.17	0.036
Chlorobenzene	ug/L	0.2	1	0.867	0.014
Ethylene Dibromide	ug/L	1	5	4.33	0.071
Benzene	ug/L	0.5	0.5	0.5	0.01
o-xylene	ug/L	1	1	1	0.021
Toluene	ug/L	1	1	1	0.021
Styrene	ug/L	1	1	1	0.021
Acrolein	ug/L	20	20	20	0.419
Acrylonitrile	ug/L	10	10	10	0.21
Octachlorodibenzo-p-dioxin	pg/L	39	95	67	0
Oil and Grease	mg/L	1	5	1.4	21.9
Chloride, Unfiltered Reactive	mg/L	43.5	415000	50000	771000
Fluoride, Unfiltered Reactive	mg/L	0.1	3.2	2.16	33.6
Sulphate, Unfiltered Reactive	mg/L	20.2	1360	1150	17600

**Table A2, General Chemical Canada Ltd., Amherstberg Plant**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0200

Description: Main Drain

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	131000	273000	203000	
COD	mg/L	13	40	27	5110
Cyanide Total	mg/L	0.005	0.031	0.012	2.41
Ammonia Plus Ammonium	mg/L	0.5	17.1	3	584
Total Kjeldahl Nitrogen	mg/L	0.4	17.3	3.3	648
Nitrate and Nitrite	mg/L	0.11	2.92	1.15	227
DOC	mg/L	1.1	6.2	2.2	442
Total Phosphorus	mg/L	0.1	0.26	0.11	22.2
Specific Conductance	uS/cm	249	800	613	
Total Suspended Solids	mg/L			29	5880
Aluminum	ug/L	120	1090	475	97.6
Copper	ug/L	10	10	10	2.06
Strontium	ug/L	110	170	137	28
Mercury	ug/L	0.1	0.36	0.12	0.024
Phenolics (4AAP)	ug/L	1	6	2.8	0.557
Sulphide	ug/L	10	215	23	4.4
Total TCDF	ug/L	220	330	275	0
Total PCDF	ug/L	29	230	130	0
Octachlorodibenzo-p-dioxin	pg/L	150	180	165	0
Oil and Grease	mg/L	1	6	1.3	264
Chloride, Unfiltered Reactive	mg/L	34	265	99.1	19800
Fluoride, Unfiltered Reactive	mg/L	0.1	2.1	0.1	25.6
Sulphate, Unfiltered Reactive	mg/L	17.6	1170	23.2	6330

**Table A3, General Chemical Canada Ltd., Amherstberg Plant**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN0600

Description: Intake

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
COD	mg/L	11	26	18.5	3746
Total Kjeldahl Nitrogen	mg/L	0.1	26	0.95	190
Nitrate and Nitrite	mg/L	0.1	2.51	0.75	149.5
DOC	mg/L	1.2	3	2.1	444.2
Specific Conductance	uS/cm	139		278	
Total Suspended Solids	mg/L		29	18.6	3965
Aluminum	ug/L	1090	50	496	107.2
Strontium	ug/L	1	160	123	26.6
Octachlorodibenzo-p-dioxin	pg/L	110	120	115	0.00002
Oil and Grease	mg/L	1	3	1.14	244.4
Chloride, Unfiltered Reactive	mg/L	8.6	198	16.9	3582
Fluoride, Unfiltered Reactive	mg/L	0.1	0.15	0.106	22.95
Sulphate, Unfiltered Reactive	mg/L	9.6	33.7	21.5	4578

**Table A4**  
**Toxicity Data for General Chemical Canada for the First Six Months of the MISA Monitoring**

Control Point	Test Species	Number of Samples	Range of Data	Number of Non-lethal Samples
CO0100	Rainbow trout	6	18.8% - 41.8%	0
	<u>Daphnia magna</u>	6	5.8%-8.8%	0
CO0200	Rainbow trout	6	100% to non-lethal	5
	<u>Daphnia magna</u>	6	100% to non-lethal	5

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS				LOADINGS			kg/d
				CO 0100	CO 0200	IN 0600	IN 0600	CO 0100	CO 0200	IN 0600	
c	Total suspended solids	5	mg/L	414	28.2	18.2	18.2	629	5950	4080	
c	Hydrogen ion (pH)			11.5	8.22	8.16	8.16				
c	Specific conductance		uS/cm	59200	573	271	271				
c	DOC	0.5	mg/L	221	2.19	2.07	2.07	3530	445	464	
c	TOC	5	mg/L	321	2.48	2.31	2.31	5080	504	518	
c	Oil and grease	1	mg/L	1.4	1.29	1.14	1.14	21.9	265	255	
c	Ammonia plus Ammonium	0.25	mg/L	5.44	2.97	0.109	0.109	80.1	586	24.5	
c	Nitrate+Nitrite	0.25	mg/L	0.831	1.15	0.747	0.747	13.2	228	168	
c	Total Kjeldahl nitrogen	0.5	mg/L	5.87	3.28	0.952	0.952	90	652	214	
c	Total phosphorus	0.1	mg/L	0.237	0.11	0.102	0.102	3.42	22.4	22.9	
09	Aluminum	30	ug/L	168	475	496	496	2.81	98	111	
09	Beryllium	10	ug/L	10	10	10	10	0.161	2.08	2.24	
09	Boron	50	ug/L	509	80.8	60.8	60.8	8.19	16.2	13.6	
09	Cadmium	2	ug/L	11.3	2.17	2	2	0.23	0.445	0.449	
09	Chromium	20	ug/L	115	19.2	20	20	2.32	4	4.49	
09	Cobalt	20	ug/L	114	20	20	20	2.33	4.15	4.49	
09	Copper	10	ug/L	66.7	10	10	10	1.29	2.08	2.24	
09	Lead	30	ug/L	232	30	32.5	32.5	4.44	6.22	7.29	
09	Molybdenum	20	ug/L	167	20	20	20	3.22	4.15	4.49	
09	Nickel	20	ug/L	69.2	10	10	10	1.38	2.08	2.24	
09	Strontium	20	ug/L	4910	137	123	123	79.9	28.1	27.5	
09	Thallium	30	ug/L	52.5	30	30	30	0.818	6.22	6.73	
09	Vanadium	30	ug/L	30.8	20	20	20	0.477	4.15	4.49	
09	Zinc	10	ug/L	55	10.8	73.3	73.3	1.12	2.23	16.5	
10	Antimony	5	ug/L	2	2	2	2	0.032	0.449	0.449	
10	Arsenic	5	ug/L	18.7		2	2	0.297		0.449	
10	Selenium	5	ug/L	2.42		2	2	0.04		0.449	
12	Mercury	0.1	ug/L	0.203	0.117	0.101	0.101	0.003	0.024	0.023	
14	Phenolics (4AAP)	2	ug/L	2.53	2.79	1.21	1.21	0.038	0.561	0.271	
15	Sulphide	20	ug/L	50.1	23.1	10	10	0.731	4.42	2.24	
16	1,1,2,2-Tetrachloroethane	4.3	ug/L	4.33	1	1	1	0.071	0.206	0.224	
16	1,1,2-Trichloroethane	0.6	ug/L	1.29	0.35	0.325	0.325	0.022	0.068	0.073	
16	1,1-Dichloroethane	0.8	ug/L	0.867	0.2	0.2	0.2	0.014	0.041	0.045	
16	1,2-Dichloroethane	0.8	ug/L	0.867	0.2	0.2	0.2	0.014	0.041	0.045	
16	1,2-Dichloropropane	0.9	ug/L	0.867	0.2	0.2	0.2	0.014	0.041	0.045	
16	Bromoforn	3.7	ug/L	8.67	2	2	2	0.142	0.412	0.449	
16	Bromomethane	3.7	ug/L	8.67	2	2	2	0.142	0.412	0.449	

Continued



General Chemical  
Amherstburg

Page 2 of 3.

ATG	PARAMETER	RMID	UNIT	CONCENTRATIONS				LOADINGS			
				CO 0100	CO 0200	IN 0600		CO 0100	CO 0200	IN 0600	kg/d
16	Chloroform	0.7	ug/L	2.23	1.1	0.2		0.04	0.213	0.045	
16	Chloromethane	3.7	ug/L	8.67	2	2		0.142	0.412	0.449	
16	Cis-1,3-Dichloropropylene	1.4	ug/L	2.17	0.5	0.5		0.036	0.103	0.112	
16	Dibromochloromethane	1.1	ug/L	4.33	1	1		0.071	0.206	0.224	
16	Ethylene dibromide	1	ug/L	4.33	1	1		0.071	0.206	0.224	
16	Methylene chloride	1.3	ug/L	2.88	0.75	0.708		0.048	0.148	0.159	
16	Tetrachloroethylene	1.1	ug/L	2.17	0.5	0.55		0.036	0.103	0.123	
16	Trans-1,3-Dichloropropylene	1.4	ug/L	2.17	0.5	0.5		0.036	0.103	0.112	
16	Trichlorofluoromethane	1	ug/L	13.5	1.05	1		0.242	0.218	0.224	
16	Vinyl chloride	4	ug/L	8.67	2	2		0.142	0.412	0.449	
17	Benzene	0.5	ug/L	0.5	0.15	0.1		0.01	0.029	0.022	
17	Styrene	0.5	ug/L	1	0.2	0.2		0.021	0.041	0.045	
17	Toluene	0.5	ug/L	1	0.2	0.2		0.021	0.041	0.045	
17	o-Xylene	0.5	ug/L	1	0.2	0.2		0.021	0.041	0.045	
18	Acrolein	4	ug/L	20	4	4		0.419	0.824	0.897	
18	Acrylonitrile	4.2	ug/L	10	2	2		0.209	0.412	0.449	
19	Fluoranthene	0.4	ug/L	0.4	0.5	0.4		0.008	0.1	0.09	
19	Phenanthrene	0.4	ug/L	0.4	0.65	0.4		0.008	0.128	0.09	
19	Pyrene	0.4	ug/L	0.4	0.45	0.4		0.008	0.092	0.09	
24	Octachlorodibenzo-p-dioxin	30	pg/L	67	165	115		-	-	-	
24	Total H6CDD	30	pg/L	19	32.5	20.5		-	-	-	
24	Total H6CDF	20	pg/L	20	56.5	23		-	-	-	
24	Total H7CDD	30	pg/L	21	32	23		-	-	-	
24	Total PCDD	20	pg/L	20	33.5	28		-	-	-	
24	Total PCDF	15	pg/L	13	130	13		-	-	-	
24	Total TCDF	15	pg/L	10	275	10		-	-	-	
2	Cyanide Total	0.005	mg/L	0.007	0.012	0.005		0.103	2.43	0.103	
98	Flow		m3/d	15300	208000						
11	Chloride	2	mg/L	47900	99.1	16.2			19800	3640	
12	Fluoride	0.1	mg/L	2.17	0.111	0.106		33.8	22.9	23.8	
13	Sulphate	5	mg/L	1160	23.2	21.5		17800	4710	4810	

Notes:

CO0100 is the 'North Drain Effluent' which discharges into the Detroit River.  
CO0200 is the 'Main Drain Effluent' which also flows to the River.

Continued

Notes continued:

Intake loadings are based on freshwater intake analyses and on the sum of mean discharge flows from 0100 and 0200. These intake loading values are probable upper bounds of the actual intake loadings due to rainfall flow contributions from the large catchment area of the plant.

Flow and loading values for CO0200 should be interpreted with caution.

A flow monitor employing depth sensing only without a purpose designed primary device was used.

The accuracy of this flow measurement method was estimated but not rigorously established or measured.

TSS values for CO0100 may be lower than indicated.

This is because metal carbonates slowly precipitate from samples during regular sampling and storage time before analysis. Grab samples which are immediately analysed for TSS show up to 50% reductions.

The high chlorides content of stream CO0100 may have affected analyses performed for other parameters.

In particular measurement of ATG 9, 16, 17 and 18 parameters required dilution before analysis which may result in high detection limits. Values shown for ATG 9, 16, 17 and 18 parameters may therefore be higher than the actual amounts present.

TOC and DOC values displayed for CO0100 may also have been affected by chlorides and may be higher than the actual levels.

## **APPENDIX 11**

### **ICI Forest Products, Cornwall**



# **ONTARIO INORGANIC CHEMICAL PLANTS**

## **REPORT ON BAT OPTIONS**

### **ICI CANADA INC. (CORNWALL)**

#### **1.0 PLANT DESCRIPTION**

The ICI Forest Products plant in Cornwall produces chlorine and caustic soda, or caustic potash by electric decomposition of brine in a mercury cell. Chlorine gas is sold and also used onsite in the production of hydrochloric acid, sodium hypochlorite and chlorinated paraffins. Caustic soda is sold, and also consumed in the production of sodium hydrosulphide and Polysulphide Red 2000™.

Water from the City of Cornwall is used onsite primarily as once through cooling water and cooling tower make-up water, in addition to wash water. A portion of water is softened for use in products and for cooling of hydrogen gas. Details on the plant, processes and wastewater generation are provided in the Site Visit Report (Ref. 1).

#### **2.0 WASTEWATER SOURCES AND QUALITY**

##### **2.1 Wastewater Sources**

One main production process at the plant, the chlorine and caustic soda (or caustic potash) unit, generates process wastewater. Wastewater sources include:

- Cell room wastewater, including wash water, depleted brine and potassium hydroxide filter backwash, which has been treated in a wastewater treatment plant for mercury removal.
- Untreated wash water from the brine mud filter press.

In addition, cooling tower blowdown, non-contact brine mud filter vacuum water and pump seal water, water softener backwash water and roof storm water are all combined for discharge with chlor-alkali plant process wastewaters. These streams, monitored under the MISA Monitoring Regulation at Control Point PR0400, are summarized in Table 1.

Discharges from other areas of the plant, including once through cooling water, cooling tower blowdown and storm water runoff, and a small amount of wash water from chlorine tank car servicing were collected in a single process sewer system, and combined with effluents monitored at PR0400 before being discharged at MISA Control Point CO0300.



**Table 1**  
**Sources of Effluents Monitored at MISA Control Point PR0400**

Source	Description	Average Flow Rate
Cell room wastewater sumps	<ul style="list-style-type: none"> <li>Wash water depleted brine, potassium hydroxide filter backwash water that have been treated in a wastewater treatment plant for mercury removal.</li> </ul>	100 m <sup>3</sup> /d
Brine muds filter press	<ul style="list-style-type: none"> <li>Wash water produced at 34 L/min. for 10 hours every 2 days.</li> </ul>	10.2 m <sup>3</sup> /d
	<ul style="list-style-type: none"> <li>Non-contact vacuum pump water, produced at 100 L/min. for 10 hours every 2 days.</li> </ul>	30 m <sup>3</sup> /d
	<ul style="list-style-type: none"> <li>Flush pump seal water, produced at 3.5 L/min. for 10 hours every 2 days.</li> </ul>	1.1 m <sup>3</sup> /d
Hydrogen cooling tower	<ul style="list-style-type: none"> <li>Non-contact cooling tower blowdown.</li> </ul>	13 m <sup>3</sup> /d
Water softener	<ul style="list-style-type: none"> <li>Backwash water.</li> </ul>	14 m <sup>3</sup> /d
Roof drains	<ul style="list-style-type: none"> <li>Storm water runoff.</li> </ul>	variable

## 2.2 Wastewater Flows and Quality

Tables A1 and A2 in the Appendix present mean, minimum and maximum flow and concentration data for those pollutants considered by the Ontario Ministry of the Environment to be "Priority 1" measured at MISA Control Points CO0300 and PR0400. Table A3 presents intake water quality data measured at IN0200.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

**Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following subsections.

### **3.1 BAT Option 1**

Toxicity data for the first six months of monitoring under the MISA Monitoring Regulation were collected and verified by the Ministry. Results of six tests on rainbow trout and 3 test on *Daphnia magna* carried out on samples of final effluent collected at MISA Control Point CO0300 are presented in Table A4. All samples were non-lethal to the test species. Therefore, no changes to the existing operation are recommended under BAT Option 1.

The plant has indicated that system changes may be implemented to reduce water usage, which would also reduce flows through CO0300. These changes should be designed to ensure that non-lethality of effluents is maintained.

### **3.2 BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), Part 415 Subpart F-Chlor-alkali Manufacturing, effluent limits for BAT were defined for mercury and total residual chlorine. These limits were based upon mercury removal by sulphide precipitation and pressure filtration, in addition to dechlorination of mercury contaminated wastewaters. This included the assumption of recycle of brine mud overflow filtrate back to the process and settling of brine mud (Ref. 2).

At ICI settled brine mud overflows and filtrate from the belt filter press for filtering brine clarifier underflows (mud) are returned back to the process. Cell room wastewater is treated in a system consisting of presetting, dechlorination, precipitation with sodium hydrosulphide and ferrous sulphate at a pH of 6.8, settling, sand filtration,

and granular activated carbon adsorption. On a technology basis, the system at ICI is more advanced than that recommended by the U.S. EPA.

Table 2 presents a comparison of the ICI treatment plant effluent quality, and the chlor-alkali plant effluent quality (measured at PR0400) to U.S. BAT limits for mercury and suggested limits for other toxic metals. Suggested limits for other toxic metals were presented in the U.S. Development Document (Ref. 2), and are intended as guidance for permit writers (Ref. 3).

Parameter	U.S. BAT Limit or Guideline		ICI WWTP Effluent	Chlor-Alkali Plant Effluent <sup>3</sup>	
	30-Days Average <sup>1</sup> (kg/d)	Maximum Day <sup>1</sup> (kg/d)	Average <sup>2</sup> (kg/d)	Average (kg/d)	Maximum <sup>4</sup> (kg/d)
Mercury	0.013	0.031	0.010	0.021	0.032
Chlorine	0.043	0.253	no data	no data	no data
Arsenic	0.028	0.061	<0.0003	0.002	0.0005
Cadmium	0.015	0.032	<0.0008	0.002	0.007
Copper	0.015	0.032	<0.0009	0.008	0.027
Lead	0.045	0.100	<0.006	0.046	0.261
Nickel	0.028	0.062	<0.002	0.011	0.038
Silver	0.020	0.043	<0.0003	n.p. <sup>5</sup>	n.p.
Zinc	0.043	0.093	0.002	0.02	0.179
Notes:					
1. Calculated from limits set on the basis of a kg/kg/d of chlorine production capacity, and reported capacity of ICI.					
2. From 6 days of testing of wastewater treatment plant effluents in November and December 1990, carried out by ICI (Ref. 1).					
3. From MISA 12 months monitoring data at Control Point PR0400.					
4. Calculated from maximum concentration and mean flow rate.					
5. Not a "Priority 1" pollutant.					

The data in Table 2 shows that the ICI treatment plant is capable of producing effluent quality well below U.S. BAT limits and guidelines. The quality of total effluents generally meets U.S. BAT limits, except for mercury, and maximum levels of lead and zinc.

Mercury exceedances were likely attributed to a few incidences of mercury breakthrough from the treatment plant during the MISA Monitoring period. Since this period, the plant has implemented effluent check tanks. Mercury concentrations in

effluents in these tanks are measured hourly, and effluents exceeding 0.13 mg/L mercury are not discharged, but are recycled back to the treatment plant. Because treatment plant effluent is the main source of mercury in streams monitored at PR0400<sup>2</sup>, loadings would not exceed 0.013 kg/d under the current operation. Therefore, with respect to achieving U.S. BAT limits for mercury, no changes to the current operation are recommended.

The primary source of toxic metals in effluents from chlor-alkali processes is impurities in the salts or brine (Ref. 2). At ICI, impurities are settled in a clarifier, and the clarifier underflow, referred to as brine muds, are filtered in a belt filter press. Filtrate is returned to the mercury cell. Wash water used to clean the filter press during operation, generated at average rate of 10.2 m<sup>3</sup>/d, contains a high TSS concentration and is a likely source of toxic metal impurities such as lead and zinc that were detected at Control Point PR0400 at maximum levels higher than U.S. BAT guidelines. The filter backwash water is not treated prior to discharge.

Assuming that a large portion of toxic metal impurities in the filter backwash stream are in the form of insoluble precipitates, removal of TSS by settling prior to discharge of this stream would reduce the levels of these metals in effluents. This is a reasonable assumption, since many of these metals would be precipitated in the clarifier. BAT Option 2 incorporates settling of this filter wash water stream, and is discussed in detail in Section 4.0.

No effluent chlorine residual data from the chlor-alkali plant were available. However, with respect to chlorine, the plant incorporates dechlorination, and therefore meets U.S. BAT on a technology basis.

A review of process and non-process effluent data measured at Control Point PR0400 shows that the chlor-alkali plant produces effluents with contaminants generally at levels well below U.S. BAT limits and guidelines. Settling of solids is recommended for the brine muds filter wash water stream under BAT Option 2 to improve removal of lead and zinc from this stream.

The U.S. Federal Register does not include BPT or BAT Regulation for effluents generated in the manufacture of hydrochloric acid, sodium hypochlorite, sodium hydrosulphide, chlorinated paraffins or other sodium sulphide compounds. Therefore, wastewater control technologies for these processes were not be defined under BAT Option 2.

---

<sup>2</sup>

ICI estimates that an average of 0.0004 kg/d of mercury is also discharged in brine mud filter press backwash water stream.



### 3.3

#### **BAT Option 3**

ICI Forest Products in Cornwall is the only mercury cell chlor-alkali production plant in Ontario. Therefore, no changes to the existing system for wastewater control are recommended under BAT Option 3.

### 3.4

#### **BAT Option 4**

BAT Option 4 includes those technologies that will provide the maximum reduction of pollutants from discharges at the plant.

A review of the MISA monitoring data at Control Points CO0300 and PR0400 indicates the presence of several groups of contaminants, including:

- TSS and VSS
- Toxic metals, including mercury
- Chlorinated volatile organics (chloroform, methylene chloride, 1,2-chloroethane).
- Trace chlorinated organics, including chlorinated benzene and dioxin and furan compounds.
- Oil and grease
- Phenolics
- Sulphide
- Phosphorus
- Chloride, fluoride and sulphate.

Technologies for the reduction of each of these contaminants are discussed.

#### **TSS and VSS**

The main source of TSS in the final effluent is the chlor-alkali effluent stream (PR0400), which contributes 152 kg/d of TSS to final effluents. ICI attributes most of these solids to the filter wash water stream, and reports that solids are primarily calcium sulphates, which have been shown to be readily settleable. Therefore, removal of these solids by settling is recommended under BAT Option 4.



A high percentage of TSS (40%) was volatile, according to the MISA monitoring data. Since organic levels in the effluents are low, the nature of the volatile portion of suspended solids is not obvious. It is thought that a portion of TSS particles are hydrated calcium sulphate molecules, and water is evaporated under the VSS test conditions (500 °C).

VSS would also be removed in the recommended settling process.

## Metals

The data in Table A1 and A2 shows that a portion of some metals in the final effluent stream are being contributed from the chlor-alkali effluent stream. Levels of aluminum, beryllium, cobalt, molybdenum, nickel, lead, thallium, vanadium, zinc and arsenic were all higher in the chlor-alkali effluents than in final effluents. These contaminants are likely from impurities in the brine, and are contributed from the brine filter wash water and treatment plant effluent (which contains depleted brine). Removal of insoluble precipitates of these metals in brine filter wash water will be accomplished through the settling treatment recommended for solids removal.

Technologies for further reduction of low levels of insoluble metals may be available. However, practical applications to treating dilute concentrations of these metals in industrial wastewaters were not identified in a global search.

Some metals, including cadmium, copper and chromium, were at similar concentrations in plant effluents as in the chlor-alkali plant effluent stream. In addition, most other metals detected, although some portion of which were contributed from the chlor-alkali process, were also contributed to the final effluent stream from other sources. Raw water used at the plant is the main source of cadmium and copper, and a source of most other metals, as shown in Table A3. In general, these metals are at dilute concentrations, and practical technologies for their removal from wastewater have not been identified. Only one metal, strontium, was detected at relatively high levels in final effluents. However, it was not analyzed intake water, and therefore, the portion of strontium contributed from this source is unknown.

A treatment process specifically aimed at strontium removal was not identified in a global search. However, strontium removal would occur with chemical coagulation and settling treatment aimed at removal of metals. However, implementation of a coagulation sedimentation, and filtration process will produce related problems which must be addressed, including:

- The impacts of water treatment chemicals on effluents, in terms of contaminant concentrations and toxicity.
- The handling and disposal of wastewater treatment residuals.

- The dependence of system reliability and operator training on performance.

Measurement of strontium in intake water is recommended to determine whether this is its source. However, because the levels do not contribute to toxicity in effluents, and because of the negative environmental impacts associated with treatment, no strontium removal processes are recommended.

The source of hexavalent chromium detected in chlor-alkali process effluents is unknown. Levels of this contaminant are low, and therefore, its presence should be confirmed through additional testing. However, the hexavalent chromium levels are too low to be considered practical for wastewater treatment. Therefore, if confirmed present, reduction of this metal will be based on source controls. It should be noted that this metal was not considered a "Priority 1" pollutant in plant effluents measured at CO0300.

### Mercury

About 37 percent of the mercury loading in final effluents from the plant is contributed from the chlor-alkali plant effluent stream. The remaining portion may be contributed from surface runoff as a result of fugitive mercury emissions, or other unidentified sources at the plant. Technologies identified in a global search for reduction of mercury levels include:

- Tertiary mercury removal in a mercury specific ion exchange resin.
- Complete elimination of mercury cells, by replacement with membrane cells.

BAT Option 4 focuses on the reduction of mercury from effluents produced in the existing process. Process change will be addressed further under BAT Option 5.

The mercury specific ion exchange resin is capable of treating mercury to levels of less than 5 µg/L in effluents from a sulphide precipitation treatment process. This technology is, therefore, recommended for treatment of mercury contaminated streams from the chlor-alkali process at ICI. Application of the ion exchange treatment system for reducing mercury levels in high flow total plant effluent streams was not identified in an exhaustive global search, and the level of pretreatment required to make cooling water and storm water flows amenable to ion exchange treatment has not been defined.

A pollution prevention approach is recommended for controlling mercury levels in final effluent discharges. This includes an audit of mercury sources and emissions, and control of these sources through improved emission control, control of inadvertent leaks and spills to effluents and best management practices.

## Chlorinated Volatile Organics

Chloroform, dibromochloromethane, 1,2-dichloroethane and methylene chloride were all detected at low levels in chlor-alkali plant effluents. Only the first two compounds were detected in final effluents, and were at the same level as those in raw water. These compounds are commonly formed in chlorinated water supplies such as the municipal water used at the plant, when organic matter in raw water reacts with chlorine.

A source of methylene chloride and 1,2-dichloroethane may be from the spent brine, which has been saturated with chlorine. Methods for their source reduction from process effluents are not likely available, since the brine must come in contact with chlorine as part of the process. Furthermore, practical technologies for the removal of any of these compounds at the low levels present in ICI effluents were not identified in a global search.

It is important to note that an exhaustive global search of chlor-alkali plants did not identify treatment or control processes in use aimed at reducing the levels of chlorinated organics in effluents covered in the previous discussion, or the trace organics to be discussed in the following section. Furthermore, locations were not identified where federal or jurisdictional agencies have applied limits on these contaminants.

## Trace Chlorinated Organics

Several trace organic compounds, including chlorinated benzenes and dioxin and furan compounds, were identified in chlor-alkali plant effluents and final plant effluents. All of these contaminants were at concentrations averaging below 2 µg/L.

Tests carried out by ICI at the wastewater treatment plant for mercury removal in 1990 found removal efficiencies for chlorinated organics to range from 25 to 96 percent over the treatment process (Ref. 1). Effluent concentrations were in the range of 1 to 222 ng/L. Presumably, the main removal process was the granular activated carbon contactor, included in the wastewater treatment system at ICI, which is a proven technology for removal of trace organic compounds.

No data were available on removal of dioxins and furans. Theoretical isotherm data for dioxin and furan compounds indicate a very high potential for adsorption on the GAC media, and virtual elimination of those compounds has been shown with GAC treatment. However, because dioxin and furan compounds are very hydrophobic and have such a high adsorption potential, they may become adsorbed on other solids in the wastewater, which may pass through a GAC contactor. Thus, a high level of solids removal is also necessary to ensure good removal efficiency of dioxins and furans.



The GAC contactor at ICI is currently not operated for optimum removal of organic compounds. Therefore, one approach to improving removal efficiency is to change operating features, such as carbon media and carbon replacement frequency, for optimization of organics removal. In addition, the brine filter washwater stream, which has been associated with spent brine from the cells and may also contain dioxin and furan and other extractable compounds, would need to be treated in the GAC contactor. Treatment of this stream in the wastewater treatment plant has already been included under BAT Option 4, and is discussed in Section 4.0

Although this approach may decrease levels of these pollutants in discharges, a more comprehensive approach involving their elimination at source is more desirable. ICI have identified two potential sources of these pollutants in effluents from the chlor-alkali plant. The most likely source is the cell sealant used in the mercury cells. This sealant, which includes a high percentage of residual oil, may contribute organic precursors to brine in the cells, which are available for formation of chlorinated compounds when chlorine is produced. The plant have recently switched the cell sealant to a silicone based product, which is used as old sealant is replaced.

A second potential source is oil and grease from various sources, that is present in wastewater from the plants mercury retort area. This wastewater is treated in the wastewater treatment system.

In order to identify an appropriate control method, an audit to confirm the source of organic precursors of chlorinated compounds is necessary. Thus, methods for their elimination through source controls such as materials substitution (e.g. replacing all sealant) or management (e.g. oil and grease separation or best management practices) can be determined.

Elimination of these contaminants through an audit and implementation of source control is recommended under BAT Option 4.

The final effluent loading data in Table A2 indicates that only a fraction of many of the chlorinated organics and dioxin furan compounds are originating from the chlor-alkali process effluent.

A careful review of the processes and raw materials used at the plant did not indicate a potential source in raw materials or chemicals of these contaminants that might contaminate cooling water or storm water generated in other areas of the plant, which were monitored at MISA Control Point CO0300. This suggests that the source of contaminants may be contaminated soil or groundwater, which is resulting in contaminated runoff. The fact that these contaminants were also detected in effluents containing groundwater seepage at the Conpak packaging facility on the ICI site provides additional basis for this conclusion.

Until the source of these pollutants can be identified, remediation measures cannot be implemented. To this end, a storm water control study is recommended.

It is noteworthy that two pollutants, hexachlorocyclopentadiene and 1,2,3-trichlorobenzene, were at similar levels in raw water, and are not likely originating from the plant.

### **Oil and Grease**

The mean oil and grease concentration of 10 mg/L in chlor-alkali plant effluents measured at PR0400 is likely contributed from a variety of sources, since lubricating and heat exchange oils are general usage chemicals at the plant. A detailed understanding of the oil sources is necessary to make specific recommendation for their control. However, because of the nature of their use, the general recommendation of in-plant management practices will incorporate all specific recommendations.

Oil and grease levels in final effluents are low, and not at practicably treatable levels. Again, a program of management practice for control of oil discharges to the process sewer at the plant is recommended.

Management practices for oil and grease control are discussed in greater detail in Section 4.0.

### **Phenolics**

Oil and grease in plant effluents are a likely source of phenols, since no other general usage chemicals that would contain this group of compounds are reportedly used at the plant. Therefore, phenol contributions from plant operations would also be reduced with oil and grease removal.

Table A3 also shows that some phenol is present in the raw water source, and would not be reduced with in-plant measures for oil and grease control. However, the phenol resulting in effluents are not at levels that have been demonstrated as practicably treatable, and therefore, no further recommendations for their removal are included in BAT Option 4.

### **Sulphide**

Sulphide, present at a mean concentration of 228 µg/L in final effluents did not originate in the chlor-alkali plant effluent stream. Sulphide compounds, including sodium hydrosulphide and PSR-2000™ are produced at the plant and use raw material sulphur and hydrogen sulphide. However, effluents are not generated from either process, and non-contact cooling water or condensate are not a likely source of sulphide. The plant has suggested that one source of sulphide is the CS<sub>2</sub> moat water from the storage area at the sodium hydrosulphide plant.



Sulphide removal using chlorine or peroxide is a well established treatment step. Chloride addition must be carefully controlled to avoid toxic residual chlorine concentrations in effluents, and an additional dechlorination step will be required. In both cases air control should be added to reduce the emissions of odorous hydrogen sulphide gases. However, since the probable source of sulphide contamination is storm water runoff as a result of fugitive emission or raw material or product spills during loading or unloading, a Storm Water Control Study is recommended for the identification and control of sulphide discharges in plant effluents.

### **Phosphorus**

Phosphorus loadings in chlor-alkali plant effluents and final effluents from ICI are higher than those in raw water, indicating a contribution from plant operations. The most likely source of this contribution is organic phosphorus based water treatment chemicals used as corrosion inhibitors for cooling tower make-up water. Although alternative chemicals could be considered, these would also add chemicals to final effluents, and therefore, the relative benefits of using another chemical are questionable. On this basis, no changes to the existing system are recommended.

### **Chloride, Fluoride and Sulphate**

Total dissolved solids, primarily chloride, fluoride and sulphate, were contributed to final effluents from plant operations. The main source of chloride is likely the mercury treatment plant effluent, which includes spent brine. Although some fluoride and sulphate are also generated from this source, loadings are also contributed from other plant areas.

A careful review of the processes at ICI does not reveal a specific source of sulphate or fluoride, and an audit of their sources is necessary to identify measures for their control at source.

Methods available for reducing total dissolved solids in wastewater include deep well injection and treatment for total dissolved solids removal. The feasibility of deep well injection of chlor-alkali plant or final effluents must be based on a detailed review of the geological characteristics of the injection area. Since this information is not available, this technology was not considered further under BAT Option 4.

Treatment methods for TDS removal include evaporation, membrane processes and electrodialysis. Brine concentration, using vapour compression evaporators has been widely used to concentrate effluents, in the treatment of cooling tower blowdown and other concentrated TDS streams in the electric power generating industry, allowing spray drying or crystallization of concentrate to produce a residual solid requiring disposal. The resulting high quality condensate can be reused in the plant as cooling tower make-up water, without requiring additional treatment. Since sulphate and

fluoride levels are not excessive in the final effluent, and chloride is primarily generated in the chlor-alkali plant, application of the brine concentrator spray drying system is recommended for the chlor-alkali plant effluent stream (i.e. PR0400) at ICI.

If total dissolved solids removal were to be considered for implementation on the final plant effluent, rather than the chlor-alkali plant effluent only, an additional preconcentration process, such as reverse osmosis or electrodialysis would be required before the brine concentrator and spray dryer or crystallizer.

### Summary

For maximum reduction of contaminants in ICI Cornwall effluents, the following technologies are recommended under BAT Option 4:

- Settling of brine mud filter press wash water for removal of TSS, VSS and insoluble toxic metal precipitates.
- Tertiary treatment of mercury bearing waste streams from the chlor-alkali process with a mercury specific ion exchange resin.
- Source identification and materials change or best management practices for elimination of discharges of trace organic compounds and dioxin and furan compounds from chlor-alkali plant effluents.
- In-plant management practices for source control of oil and grease discharges into process sewers.
- Zero-discharge of chlor-alkali plant effluents by treatment in a brine concentrator and crystallizing system for maximum reduction of total dissolved solids, particularly chloride, from effluents.

It should be noted that in spite of zero-discharge of chlor-alkali process effluents, upstream treatment processes described above are recommended, for the following reasons:

- Mercury is volatile and would not be removed in the brine concentrator, but would end up in the condensate.
- Concentrating the trace organics such as chlorinated benzene and dioxin furans in the chlor-alkali plant effluents would contaminate the residual solids, which would in effect transfer the pollutants from one medium to another. A pollution prevention approach, as described, is more desirable.

- The zero-discharge system may not be implemented in the short term, and upstream pollution reduction measures should therefore, be implemented.

### **3.5 BAT Options 5**

BAT Option 5 covers those technologies that move the plant furthest towards zero-discharge of contaminants. Rationale for developing recommendations for BAT Option 5 are discussed with respect to:

- Mercury
- Chlor-alkali plant
- Total plant effluents

#### **Mercury**

The use of mercury cells for chlor-alkali manufacturing has been essentially phased out in the U.S. to eliminate the discharge of asbestos, lead and mercury. In the mid-1970s, there were 27 mercury cells plants in the U.S. (Ref. 2) compared to 16 in 1991 (Ref. 6). The industry has essentially switched to platinum-ruthenium electrodes with membrane cells.

In general, wastewaters produced in the membrane cell process are of similar quality to the mercury cell process. Brine muds are clarified and filtered in the same manner, depleted brine is discharged and wastewaters also include cell room washdown water. The significant difference associated with the membrane cell process is the elimination of mercury from process effluents. In addition, mercury, which is ubiquitous at mercury cell plants because of its volatility and the significant emissions to air that occur, is eliminated from effluents.

Zero-discharge of mercury can theoretically be achieved with the implementation of a membrane cell process at ICI, and is therefore, recommended under BAT Option 5.

It is, however, significant to note that true elimination of mercury from discharges is not achieved in the short-term. Experience has shown that decommissioning and soil clean-up of mercury at new diaphragm cell plants that had been converted from mercury cells is a long-term process (Ref. 4, Ref. 7).

#### **Total Plant Effluents**

ICI have examined at a conceptual level the possibility of achieving zero-discharge of non-process related streams generated at the plant. Zero-discharge can be achieved by:

- Installation of a cooling tower to reduce the amount of once through cooling water and total plant discharges (by approximately 3,000 m<sup>3</sup>/d) (Ref. 1). New cooling towers are currently being brought on-line to reduce intake water requirements.
- Passing effluents through a reverse osmosis unit followed by an evaporation unit, and a spray dryer to dry the concentrated stream.
- Reuse of reverse osmosis effluents and evaporator condensate in the plant.

Since the implementation of the membrane cell systems and the chlor-alkali effluent zero-discharge system will likely produce effluent contaminant loading not significantly different from intake water, the advantages of a total plant effluent zero-discharge system are not apparent, and it is not therefore, included under BAT Option 5.

### 3.6 Summary of BAT Options

Table 3 presents a summary of five BAT Options recommended for ICI Forest Products in Cornwall, Ontario.

<b>Table 3</b> <b>Summary of BAT Options for ICI Forest Products in Cornwall</b>		
<b>Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	<ul style="list-style-type: none"> <li>• No change to existing system.</li> </ul>
2	U.S. BAT	<ul style="list-style-type: none"> <li>• Settling of brine mud filter press wash water in chlor-alkali plant.</li> </ul>
3	Best demonstrated in Ontario	<ul style="list-style-type: none"> <li>• No change to existing system.</li> </ul>
4	Maximum pollutant reduction	<ul style="list-style-type: none"> <li>• Settling of brine mud filter press wash water.</li> <li>• Mercury specific ion exchange treatment of contaminated streams in the chlor-alkali plant.</li> <li>• Source identification and elimination of trace chlorinated organic compounds in the chlor-alkali plant.</li> <li>• In-plant management practices for control oil and grease.</li> <li>• Concentration and drying of chlor-alkali plant effluents and reuse of condensate in plant.</li> </ul>
5	Furthest toward zero-discharge of pollutants	<ul style="list-style-type: none"> <li>• Conversion of chlor-alkali process to membrane cell.</li> <li>• In-plant management practices for control of oil and grease.</li> <li>• Concentration of drying of chlor-alkali plant effluents and reuse of condensate in plant.</li> </ul>



## **4.0            BAT OPTIONS**

BAT Options 1 and 3 were defined as no changes to the existing wastewater management system at ICI. BAT Options 2, 4 and 5 are described in the following subsections.

### **4.1            BAT Option 2**

#### **Description**

BAT Option 2 involves implementation of settling of the brine mud filter wash water for removal of TSS, VSS and insoluble metal precipitates.

The plant is currently commissioning a new settler for the wastewater treatment system, and can feasibly use the old settler for settling of this wash water, with minimal capital expenditures to the plant. The settler has a 15 m<sup>3</sup> capacity, and would therefore provide 7.5 hours of retention time for the wash water flows, which are generated at a rate of 2 m<sup>3</sup>/h for 10 hours every other day. This is much higher than typical time for settling (Ref. 10), and since the solids are reported to be very settleable, good removal should be achievable. Overflows from the settler would be discharged through Control Point PR0400, while underflows would be returned to the brine settler.

#### **Performance**

Treatability tests are required to determine the removal efficiency of TSS, VSS and metals from the filter wash water stream, and from the total chlor-alkali plant effluent (PR0400). Estimated performance is based on achieving U.S. BAT for lead and zinc presented in Table 4.

#### **Costs**

Since the settler proposed for sedimentation of filter press water is already existing at the plant, it is assumed capital expenditures for commissioning it for this purpose would be negligible. Furthermore, operating requirements are also expected to be small.



**Table 4**  
**Projected Performance for Implementation of BAT Option 2<sup>1</sup>**

Parameter	Current Loading at PR0400 <sup>2</sup>	Projected Loading PR0400	Loading Reduction
TSS (kg/d)	152	5 <sup>4</sup>	147 (97%)
VSS (kg/d)	63	25 <sup>5</sup>	61 (97%)
Mercury (kg/d)	0.021	0.013 <sup>5</sup>	0.008 (38%)
Lead (kg/d)	0.046	0.045 <sup>6</sup>	>0.001 (>2%)
Zinc (kg/d)	0.020	0.020 <sup>6</sup>	>0.0 (>0%)

Notes:

1. Projected reduction estimated for TSS, VSS, mercury and toxic metals not currently meeting U.S. BAT guidelines.
2. Average loading for 12 months MISA Monitoring Regulation period at PR0400. Data for mercury based on current operation.
3. Assuming achievable effluent concentrations of 20 mg/L, and total solids loading from brine filter wash water.
4. Assuming TSS/VSS ratio for total loading.
5. Assumes all mercury is soluble, and therefore mercury removal is not achievable. However achievable mercury level presented is based on current wastewater treatment plant operation (i.e. effluent concentrations <0.130 mg/L).
6. Assumes that at least U.S. BAT limits will be met for metals not achieving limits.

## 4.2 BAT Option 4

### 4.2.1 Chlor-Alkali Process Effluents

#### Description

Under BAT Option 4, the following treatment was recommended for the chlor-alkali process effluents:

- Settling of brine mud filter wash water.
- Ion exchange treatment of mercury bearing wastewater, which includes effluent from the mercury sulphide treatment plant and brine mud filter wash water. The latter stream has a reported mercury concentration of 38 µg/L (Ref. 5).

Since the filter wash water stream does not have mercury concentrations treatable by the sulphide precipitation process, it does not need to be added to the treatment plant. However, solids must be reduced in this stream to a sufficient level to avoid fouling of the ion exchange resin. It is therefore proposed that this stream be settled in the "old" settler, as described under BAT Option 2, and enter the treatment plant just upstream of the sand filter, as shown in Figure A1. The treatment plant reportedly has the capacity to treat the addition volume of filter wash water.

The mercury specific ion exchange system is described in detail in the General Technology report (Ref. 8). Table 5 presents design details for ICI.

<p style="text-align: center;"><b>Table 5</b> <b>Mercury Specific Ion-Exchange System Design Details</b></p>	
Component	Value
Flow rate	229 m <sup>3</sup> /d <sup>1</sup>
Resin loading rate (volume of effluent per volume of resin per hour)	38 h <sup>-1</sup>
Bed depth	1.2 m
Loading rate	0.8 m/min
Influent mercury concentration	130 µg/L <sup>2</sup>
Regeneration frequency	>4 y
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Capacity of treatment plant.</li> <li>2. Based on current operation.</li> </ol>	

### Performance

The mercury specific ion exchange resin is capable of achieving 5 µg/L mercury in effluents on a consistent basis (Ref. 8).

Because the filter wash water stream will be treated through the sand filter, and GAC filter, TSS levels will be reduced in effluent to 2 mg/L, the reported current treatment plant effluent quality (Ref. 1). In addition, with this level of treatment, toxic metal removal efficiencies would also be higher, although treatability tests are required to determine these efficiencies.

Table 6 presents the estimated loading of selected parameters at PR0400 and final effluent CO0300 with the implementation of the mercury specific ion exchange resin. If the proposed system were implemented, final effluent loadings of TSS would be reduced 77 percent, and mercury loadings, by 35 percent.

### Costs

Because the proposed settler for the brine filter wash water is existing at the plant, costs to bring it on-line and to install connections for overflows to enter the sand filter are estimated to be small. Furthermore, operating costs for this installation are assumed to be negligible.

The total capital cost for complete implementation of a mercury specific ion exchange resin capable of treating the full wastewater treatment plant capacity is estimated at \$890,000 (ENR CCI 6343)<sup>3</sup>. Operating costs are projected to be negligible (Ref. 8).

<sup>3</sup> Engineering News Record Construction Cost Index.

**Table 6**  
**Projected Performance for Implementation of Mercury Specific Ion Exchange Resin**

Parameter	Chlor-Alkali Effluent PR0400			Final Effluent CO0300		
	Current Quality <sup>1</sup>	Projected Quality	Loading Reduction	Current Quality <sup>1</sup>	Projected Quality	Loading Reduction
TSS (kg/d)	152	0.5	>99%	197	45	77%
TSS (mg/L)	600	2		48	11	
Mercury (kg/d)	0.021	0.0006 <sup>2</sup>	97%	0.057	0.037	35%
Mercury (mg/L)	0.139	0.002 <sup>3</sup>		0.015	0.009	
<b>Notes:</b> 1. Based on 12 months mean data for MISA Control Points PR0400 and CO0300. 2. Based on achieving 5 µg/L mercury concentrations in 110 m <sup>3</sup> /d of flow. 3. Assumes only wastewater treatment plant effluent and filter wash waters (estimated total 100 m <sup>3</sup> /d) contain mercury which would be reduced to 0.005 mg/L. When mixed with other effluents at PR0400, diluted concentration of 0.002 mg/L is estimated. 4. Includes mercury loading currently contributed from sources other than PR0400.						

#### **4.2.2 Trace Organics Reduction**

##### **Description**

The complete elimination of trace organics from chlor-alkali process effluent and final effluents should be achievable with elimination of the source. A storm water control study is recommended for detection of sources in general plant effluents. Two potential sources in the chlor-alkali plant have been identified by the plant, including the cell sealant compound and oil and grease in effluents from the retort area. An audit is recommended to confirm their source.

Remediation measures will vary, depending on the source and cannot be defined in detail at this time. If the likely source, the cell sealant, is confirmed, then a program for complete replacement with an alternate product is recommended. It should be noted that the plant has already begun to replace the former cell sealant, which is suspected source of chlorinated organic precursors, with a silicone based product.

##### **Performance**

As discussed earlier, the chlor-alkali plant appears to be one source of trace chlorinated organic compounds in final effluent. Therefore, implementation of source elimination procedures will result in zero-discharge of these contaminants at Control Point CO0400. Table 7 presents the projected loading reduction for the contaminants of concern. Based on the calculations, 3 to 50 percent of individual containment loadings would be reduced.

**Table 7**  
**Projected Performance for Implementation of Source Elimination of Trace Chlorinated Organics**

Parameter	Chlor-Alkali Effluent PR0400			Final Effluent CO0300		
	Current Quality <sup>1</sup>	Projected Quality	Loading Reduction	Current Quality <sup>1</sup>	Projected Quality	Loading Reduction
Hexachlorobutadiene • g/d • ng/L	0.07 345	0 0	100% 100%	0.44 110	0.37 92.5	16%
Hexachlorocyclopentadiene • g/d • ng/L	0.01 37	0 0	100% 100%	0.06 15.7	0.05 13.1	17%
Hexachlorobenzene • g/d • ng/L	0.04 182	0 0	100% 100%	0.30 74	0.26 64	3%
Hexachloroethane • g/d • ng/L	0.35 1,530	0 0	100% 100%	3.8 956	3.5 868	9%
Octachlorostyrene • g/d • ng/L	0.02 95	0 0	100% 100%	0.07 18	0.05 12.9	29%
Pentachlorobenzene • g/d • ng/L	0.03 115	0 0	100% 100%	0.06 16.2	0.03 8.1	50%
1,2,3-Trichlorobenzene • g/d • ng/L	0.01 34	0 0	100% 100%	0.06 13.8	0.05 11.5	17%
1,2,4-Trichlorobenzene • g/d • ng/L	0.11 469	0 0	100% 100%	0.38 95	0.27 68	29%
Total TCDF • mg/d • pg/L	1.7 7,620	0 0	100% 100%	0.004 997	0.002 573	42%
Octachlorodibenzofuran • mg/d • pg/L	0.0002 760	0 0	100% 100%	0.0005 113	0.0003 137	40%
Notes:						
1. All loadings calculated from 12 month mean concentrations and average flow rate at MISA Control Points PR0400 and CO0300.						

## Costs

The costs of carrying out the audit, including analytical work, are estimated to be less than \$25,000. The costs of replacing cell sealant were not available from the plant at the time of report writing. If the source is wastewater from the retort area, the a



detailed review of control methods is necessary, and costs for implementation of these will need to be determined by ICI.

#### **4.2.3            Management Practices for Oil and Grease Control**

##### **Description**

Management practices for control of oil and grease discharges cannot be specifically identified without a detailed understanding of the plant, and potential sources. Some general procedures that could be considered include:

- Containment of high risk oil leak or spill locations.
- Placing oil absorbent pads or socks around equipment.
- Using oil absorbent pads in wastewater collection sumps to absorb visible oil sheens.
- Implementation of a surface oil skimmer on the wastewater treatment plant settling tank.
- Other methods, depending on nature of discharge.

##### **Performance**

The oil and grease removal performance resulting from implementation of in-plant management practices was arbitrarily estimated to be represented by the "best" month over the twelve month MISA Monitoring period. Estimated performance is presented in Table 8. It is assumed that phenolics levels are directly related to oil and grease levels.

##### **Costs**

Costs for implementing management practices for oil and grease are not projected to be high. However, these cannot be quantified until appropriate practices have been defined.



<p align="center"><b>Table 8</b>  <b>Projected Performance for Implementation of In-Plant Management Practices for Oil and Grease Control in the Chlor-Alkali Plant</b></p>						
Parameter	Chlor-Alkali Effluent PR0400			Final Effluent CO0300		
	Current Quality <sup>1</sup>	Projected Quality <sup>2</sup>	Loading Reduction	Current Quality <sup>1</sup>	Projected Quality <sup>1</sup>	Loading Reduction
Oil & Grease (kg/d)	2.1	0.7	67%	6.9	<4.0	>42%
Oil & Grease (mg/L)	9.8	3.3		1.8	<1	
Phenols (kg/d)	0.001	0.0003	67%	0.014	0.008	>42%
Phenols (µg/L)	4.6	1.5		3.7	2.0	
<p>Notes:</p> <p>1. Based on 12 months mean data for MISA Control Points PR0400 and CO0300.</p> <p>2. Based on lowest monthly concentration data observed over 12 month monitoring period, and 12 month mean flow.</p>						

#### 4.2.4 Total Dissolved Solids Removal

##### Description

Removal of the total dissolved solids, particularly chloride, from chlor-alkali plant effluents (measured at PR0400) can be achieved with the implementation of a vapour compression evaporator (brine concentrator) followed by a crystallizing evaporator and centrifuge. In order to minimize equipment capacity requirements, segregation of storm water runoff flows is recommended. Therefore, the system would be designed to treat an average flow rate of 200 m<sup>3</sup>/d, including all chlor-alkali plant discharges currently monitored at PR0400 except roof runoff.

The brine concentrator and crystallizing system is described in the general technology report (Ref. 9). The brine concentrator basically involves mixing the influents stream with a recirculating brine slurry, which continuously moves to the top of evaporation tubes, and flows down to a sump, vaporizing as it falls. The vapour is compressed, condensed on the outside of the tube, and exits the unit to a distillate tank. Approximately 92 percent of distillate is recovered, which is of high, demineralized quality acceptable for reuse in the plant as cooling tower make-up water.

The concentrated waste slurry from the brine concentrator is conveyed to a crystallizing evaporator and centrifuge, where the remaining water is evaporated. The dried solids would be stored in a water tight container, until being disposed in a secure landfill.

## Performance

If the brine concentrator were implemented on the ICI chlor-alkali plant effluent stream, removal of all contaminants from direct discharge would be achieved. However, condensate that is reused at the plant would contain volatile pollutants, including mercury and volatile organics (chloroform, dibromochloromethane, methylene chloride and 1,2-dichloroethane) which would be ultimately discharged after reuse. Table 9 presents the overall loading reduction of select, target parameters that would be achieved with implementation of the system.

**Table 9**  
**Projected Performance for Implementation of Brine Concentrator and Dryer of Chlor-Alkali Plant Effluents**

Parameter	Chlor-Alkali Effluent PR0400			Final Effluent CO0300		
	Current Quality <sup>1</sup>	Projected Quality	Loading Reduction	Current Quality <sup>1</sup>	Projected Quality	Loading Reduction
Flow (m <sup>3</sup> /d)	229	29 <sup>2</sup>	87%	4,010	3,810	5%
Mercury (kg/d)	0.021	0.0006 <sup>3</sup>	97%	0.057	0.037 <sup>3</sup>	35%
Mercury (mg/L)	0.139	0.002 <sup>3</sup>		0.015	0.009 <sup>3</sup>	
Chloride (kg/d)	3,688	0	100%	3,942	254	94%
Chloride (mg/L)	16,800	0		1,050	67	
Fluoride (kg/d)	0.3	0	100%	4.9	4.6	6%
Fluoride (mg/L)	1.3	0		1.1	1.2	
Sulphate (kg/d)	293	0	100%	1,190	897	25%
Sulphate (mg/L)	1,300	0		293	235	
Notes:						
1. Based on 12 months mean data for MISA Control Points PR0400 and CO0300.						
2. Estimated mean storm water flow at PR0400.						
3. Based on implementation of mercury specific ion exchange resin.						

## Costs

The total cost estimated for implementation of a system to handle 200 m<sup>3</sup>/d is \$2,600,000 (ENR CCI 6343). Operating costs, including energy and disposal of 7 t/d of dried solids, are estimated at \$900,000 (1991) per annum.

### 4.2.5 Summary of BAT Option 4

Table 10 presents a summary of recommendations, and their estimated costs, and projected performance with respect to ICI final effluent loadings at MISA Control Point CO0300.

Implementation of BAT Option 4 will cost an estimated \$3.4 million capital and \$900,000 per year operating.

**Table 10**  
**Summary of Costs and Performance of BAT Option 4**

Recommendation	Cost <sup>1</sup>	Parameter	Current Loading at CO0300	Projected Loading at CO0300	Loading Reduction
Upstream settling of filter wash water and treatment of mercury wastes in ion-exchange unit	\$890,000 capital negligible operating	TSS (kg/d) Mercury (kg/d)	197 0.057	45 0.037	77% 35%
Source elimination of chlorinated organics in chlor-alkali effluent stream	>\$25,000	Hexachlorobutadiene (g/d) Hexachlorocyclopentadiene (g/d) Hexachlorobenzene (g/d) Hexachloroethane (g/d) Octachlorostyrene (g/d) Pentachlorobenzene (g/d) 1,2,3-Trichlorobenzene (g/d) 1,2,4-Trichlorobenzene (g/d) Total TCDF (mg/d) Octachlorobenzofuran (mg/d)	0.44 0.06 0.30 3.8 0.07 0.06 0.06 0.38 0.004 0.0005	0.37 0.05 0.26 3.5 0.05 0.03 0.05 0.27 0.002 0.0003	16% 17% 3% 9% 17% 50% 17% 29% 42% 40%
Management practices for oil and grease control	Undefined	Oil & Grease (kg/d) Phenols (kg/d)	6.9 0.014	<4.0 <0.008	>42% >42%
Evaporation and drying of chlor-alkali plant effluents	\$2,500,000 capital \$900,000 operating	Chloride (kg/d) Fluoride (kg/d) Sulphate (kg/d)	3,942 4.9 1,190	254 4.6 897	94% 6% 25%
Total Cost	>\$3,415,000 capital \$900,000 operating				
Notes:					
1. All costs are order-of-magnitude estimates.					

## 4.3 BAT Option 5

### Description

The following technologies were recommended under BAT Option 5:

- Conversion of mercury cell process to membrane cell.
- Management practices for source control of oil and grease.

- Concentration and drying of chlor-alkali plant effluents and reuse of condensate in the plant.

The former technology is discussed below, while the latter two are the same as those presented under BAT Option 4. Therefore, performance with respect to oil and grease, phenols, total dissolved solids and trace chlorinated organics would be the same as estimated for implementation of BAT Option 4.

A review of the conversion process to a membrane cell plant was based on one Canada plant, recently converted in 1990. The site visit information report provides detailed (Ref. 4).

In the case reviewed, conversion made use of much of the equipment from the mercury cell plant, including rectifiers, transformers, salt storage and brine treatment systems, and chlorine liquidification facilities. The operation of chlorine production facilities was only halted for two months between shut-down of the old process and start-up of the new process.

Several savings in operating costs were realized with the membrane cell operation including:

- Energy
- Labour
- Hazardous waste disposal
- Mercury monitoring costs
- Eventual elimination of mercury treatment plant.

### **Performance**

The conversion of mercury cell to membrane cell process will completely eliminate the discharge of mercury from air and wastewater emissions from the treatment plant. Table 11 presents the projected loading reduction.

It is important to note that decommissioning of the old mercury site will likely require long term continuing treatment of contaminated ground water and runoff for mercury removal. A treatment system consisting of the existing mercury sulphide precipitation plant plus the mercury specific ion exchange resin can be used, and would result in effluent discharge concentrations of 0.005 mg/L mercury. Loadings will be based on flow rates.



<p align="center"><b>Table 11</b>  <b>Projected Performance for Implementation of Membrane Cell Process for Chlorine Production<sup>1</sup></b></p>						
Parameter	Chlor-Alkali Effluent PR0400			Final Effluent CO0300		
	Current Quality <sup>2</sup>	Projected Quality	Loading Reduction	Current Quality <sup>2</sup>	Projected Quality	Loading Reduction
Mercury (kg/d)	0.021	0.0	100%	0.057	0.0	100%
Mercury (mg/L)	0.139	0.0	100%	0.015	0.0	100%
<p>Notes:</p> <p>1. Performance does not include loading from site decommissioning project.</p> <p>2. Based on 12 month mean data for MISA Control Points PR0400 and CO0300.</p>						

## Costs

The total cost for converting the existing mercury well chlor-alkali plant at ICI to a membrane cell process is estimated at \$34,000,000 (ENR CCI 6343) (Ref. 4). This cost should be considered order-of-magnitude, and is variable depending on the level of reuse of equipment from the mercury cell plant.

Operating costs or savings associating with the membrane cell facility were not available.

Table 12 summarizes the costs of BAT Option 5 technologies. The total estimated capital cost is \$36.5 million (ENR CCI 6343).

<p align="center"><b>Table 12</b>  <b>Summary of BAT Option 5 Costs</b></p>		
Technology	Capital Cost <sup>1</sup>	Operating Cost (\$1991)
Conversion of mercury cell process to membrane cells.	\$34,000,000	Undefined
Best management practices for oil and grease control.	Undefined	Undefined
Evaporation and drying of chlor-alkali plant effluents.	\$2,500,000	\$900,000
<b>Total</b>	<b>\$36,500,000</b>	<b>\$900,000</b>
<p>Notes:</p> <p>1. ENR CCI 6343.</p>		

## 5.0 SUMMARY OF COSTS AND PERFORMANCE OF BAT OPTIONS

Table 13 presents a summary of the costs and pollutant loading reduction estimated for each BAT Option.



Table 13 Summary of Costs and Performance of BAT Options for ICI Cornwall					
Component	BAT Option 1	BAT Option 2	BAT Option 3	BAT Option 4	BAT Option 5
Costs					
Capital	\$0				\$36,500,000
Operating	\$0	negligible	\$0	>\$3,415,000	\$900,000
Performance					
	(Loading Reduction)				
TSS (kg/d)	0	147	0	152	152
VSS (kg/d)	0	61	0	63	63
Mercury (kg/d)	0.0081	0.0081	0.0081	0.02	0.057
Lead (kg/d)	0	>0.001	0	>0.001	>0.001
Zinc (kg/d)	0	>0.0	0	>0.0	>0.0
Hexachlorobutadiene (g/d)	0	0	0	0.07	0.07
Hexachlorocyclopentadiene (g/d)	0	0	0	0.01	0.01
Hexachlorobenzene (g/d)	0	0	0	0.04	0.04
Hexachloroethane (g/d)	0	0	0	0.30	0.30
Octachlorostyrene (g/d)	0	0	0	0.02	0.02
Pentachlorobenzene (g/d)	0	0	0	0.03	0.03
1,2,3-Trichlorobenzene (g/d)	0	0	0	0.01	0.01
1,2,4-Trichlorobenzene (g/d)	0	0	0	0.11	0.11
Total TCDF (mg/d)	0	0	0	0.002	0.002
Octachlorodibenzofuran (mg/d)	0	0	0	0.0002	0.0002
Oil & Grease (kg/d)	0	0	0	>2.9	>2.9
Phenols (kg/d)	0	0	0	>0.006	0.006
Chloride (kg/d)	0	0	0	3,688	3,688
Fluoride (kg/d)	0	0	0	0.3	0.3
Sulphate (kg/d)	0	0	0	293	293
Toxicity					
Rainbow trout	non-lethal	non-lethal	non-lethal	non-lethal	non-lethal
Daphnia magna	non-lethal	non-lethal	non-lethal	non-lethal	non-lethal
Notes:					
1. Based on current operation of wastewater treatment plant compared to 12 month MISA monitoring results.					

REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report, ICI Canada Inc. (Cornwall). April 23, 1991. (unpublished).
2. Development Document for Effluent Limitations, Guidelines and Standards for the Inorganic Chemicals Manufacturing Point Source Category, U.S. EPA, EPA 440/1-79/007. June 1980.
3. Personal conversation with Dr. Thomas Fielding, U.S. EPA. March 1991.
4. Inorganic Chemical Sector Global Study Site Visit Information Report PPG Canada Inc.
5. Telephone communication with Neil MacLean, Environmental Engineer with ICI Canada, Inc., October, 1991.
6. Information provided by the Chlorine Institute. July 1991.
7. Telephone conversation with Jim Van Domlen of LCP Chemicals in Solvay, New York, 1991.
8. General Technology Report Mercury Specific Ion Exchange Resin.
9. General Technology Report for Brine Concentrator and Spray Dryer Systems.
10. General Technology Report for Sedimentation for TSS Removal.

## **APPENDIX**

### **Tables and Figures**



**Table A1, ICI Canada Inc.(Cornwall)**  
**Summary of Flows and Priority One Pollutants**  
**MISA Control Point: CO-0300**  
**Description: LEL-2**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1230	8450	4010	
COD	mg/L	13	200	65	239.074
Total Kjeldahl Nitrogen	mg/L	0.355	0.8	0.484	2.027
Nitrate and Nitrite	mg/L	0.025	86	1.977	7.839
DOC	mg/L	1.65	7.4	3.9	16.109
TOC	mg/L	2.1	23.1	5.29	22.674
Total Phosphorus	mg/L	0.02	0.599	0.201	0.804
Specific Conductance	uS/cm	4	41300	3050	
Total Suspended Solids	mg/L	3	449	48	197.431
VSS	mg/L	1	30	19.8	92.106
Aluminum	ug/L	27	390	139	0.598
Boron	ug/L	17	830		0.997
Cadmium	ug/L	0.2	5.9	0.9	0.035
Chromium	ug/L	8	55	22	0.084
Copper	ug/L	7	44	20	0.082
Lead	ug/L	10	350	53	0.207
Strontium	ug/L	550	4600	3240	14.326
Zinc	ug/L	8	585	29	0.11
Mercury	ug/L	0.2	372	15	0.057
Phenolics (4AAP)	ug/L	1.3	11	3.69	0.014
Sulphide	ug/L	10	560	228	0.85
Dibromochloromethane	ug/L	0.4	4.25	0.81	0.004
Chloroform	ug/L	5	48	10.4	0.043
Hexachlorobutadiene	ng/L	2.3	881	110	0.0004411
Hexachlorocyclopentadiene	ng/L	3.8	23.5	15.7	0.0000630
Hexachlorobenzene	ng/L	3.6	573	74	0.0002967
Hexachloroethane	ng/L	3	9140	956	0.0038336
Octachlorostyrene	ng/L	1.2	102	18	0.0000722
Pentachlorobenzene	ng/L	1.1	52.2	16.2	0.0000650
1,2,3-Trichlorobenzene	ng/L	2	44	13.8	0.0000553
1,2,4-Trichlorobenzene	ng/L	1.8	703	95	0.0003810
Total TCDF	pg/L	7.5	2400	997	0.0000040
Octachlorodibenzofuran	pg/L	22	340	113	0.0000005
Oil and Grease	mg/L	0.9	9.1	1.79	6.926
Chloride, Unfiltered Reactive	mg/L	104.4	5220	1050	3942.453
Fluoride, Unfiltered Reactive	mg/L	0.93	1.35	1.12	4.898
Sulphate, Unfiltered Reactive	mg/L	28	836	298	1190.513

For validated data  
see final table.



**Table A2, ICI Canada Inc. (Cornwall)**  
**Summary of Flows and Priority One Pollutants**  
**MISA Control Point: PR0400**  
**Description: Manhole 15**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	19.7	6700	229	
COD	mg/L	77	1200	593	153.504
Cyanide Total	mg/L	0.002	1.55	0.392	0.059
Hydrogen Ion (pH)		7.4	11.5	8.8	
Total Kjeldahl Nitrogen	mg/L	0.21	1.4	0.537	0.12
Nitrate and Nitrite	mg/L	0.025	3.8	0.444	0.094
DOC	mg/L	3.25	35	10.936	2.242
TOC	mg/L	8.9	30	14.3	3.148
Total Phosphorus	mg/L	0.13	3	0.727	0.172
Specific Conductance	uS/cm	1490	69800	19600	
Total Suspended Solids	mg/L	4	9400	600	152.32
VSS	mg/L	11	500	243	62.875
Aluminum	ug/L	26	7380	502	0.102
Boron	ug/L	280	1760	35	0.157
Beryllium	ug/L	1.6	29	10	0.002
Cadmium	ug/L	4.3	97	7.8	0.002
Cobalt	ug/L	2	62	34.6	0.008
Chromium	ug/L	3	119	37	0.008
Copper	ug/L	5	93	28	0.005
Molybdenum	ug/L	3.3	168	47	0.011
Nickel	ug/L	5	1140	183	0.046
Lead	ug/L	860	9800	3860	1.034
Strontium	ug/L	25	144	56	0.013
Thallium	ug/L	11	260	71	0.021
Vanadium	ug/L	10	783	97	0.02
Zinc	ug/L	3	23.5	7.8	0.002
Arsenic	ug/L	3.1	17	10	0.002
Chromium (Hexavalent)	ug/L	7.5	5500	139	0.021
Mercury	ug/L	1.35	17.7	4.58	0.001
Phenolics (4AAP)	ug/L	0.42	5.1	2.74	0.001
Dibromochloromethane	ug/L	4.38	41	20	0.004
Chloroform	ug/L	0.92	8.9	3.98	0.001
Methylene Chloride	ug/L	0.51	1.165	0.829	0.000189
1,2-Dichloroethane	ng/L	2.3	1180	345	0.000079
Hexachlorobutadiene	ng/L	8	105	37	0.000008
Hexachlorocyclopentadiene	ng/L	3.6	722	182	0.000041
Hexachlorobenzene	ng/L	14	7250	1530	0.000350
Hexachloroethane	ng/L	1.2	393	95	0.000021
Octachlorostyrene	ng/L	4	414.5	115	0.000026
Pentachlorobenzene	ng/L				

For validated data  
see final table

**Table A2, ICI Canada Inc. (Cornwall)**  
**Summary of Flows and Priority One Pollutants**  
**MISA Control Point: PR0400**  
**Description: Manhole 15**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
2,4,5-Trichlorotoluene	ng/L	1.4	152	44.8	0.000010
1,2,3-Trichlorobenzene	ng/L	3.2	109	34	0.000007
1,2,3,4-Tetrachlorobenzene	ng/L	1.2	110	27	0.000006
1,2,3,5-Tetrachlorobenzene	ng/L	2.1	91.8	13.5	0.000003
1,2,4-Trichlorobenzene	ng/L	2.4	1960	469	0.000107
1,2,4,5-Tetrachlorobenzene	ng/L	1.1	112	21.5	0.000004
Total TCDD	pg/L	11	520	75	0.000000
Total TCDF	pg/L	7.5	3400	7620	0.000001
Total PCDD	pg/L	13	3400	476	0.000000
Total PCDF	pg/L	22	2900	2900	0.000000
Total H6CDD	pg/L	22	190	60	0.000000
Total H6CDF	pg/L	15	5200	1210	0.000000
Total H7CDF	pg/L	20	4700	1140	0.000000
Octachlorodibenzofuran	pg/L	22	3700	760	0.000000
Oil and Grease	mg/L	0.9	47.6	9.8	2.048
Chloride, Unfiltered Reactive	mg/L	4900	29000	16800	3688.372
Fluoride, Unfiltered Reactive	mg/L	0.88	1.89	1.31	0.323
Sulphate, Unfiltered Reactive	mg/L	770	1600	1300	293.597

For validated data  
see final table.

**Table A3, ICI Canada Inc.(Cornwall)**

Summary of Flows and Priority One Pollutants

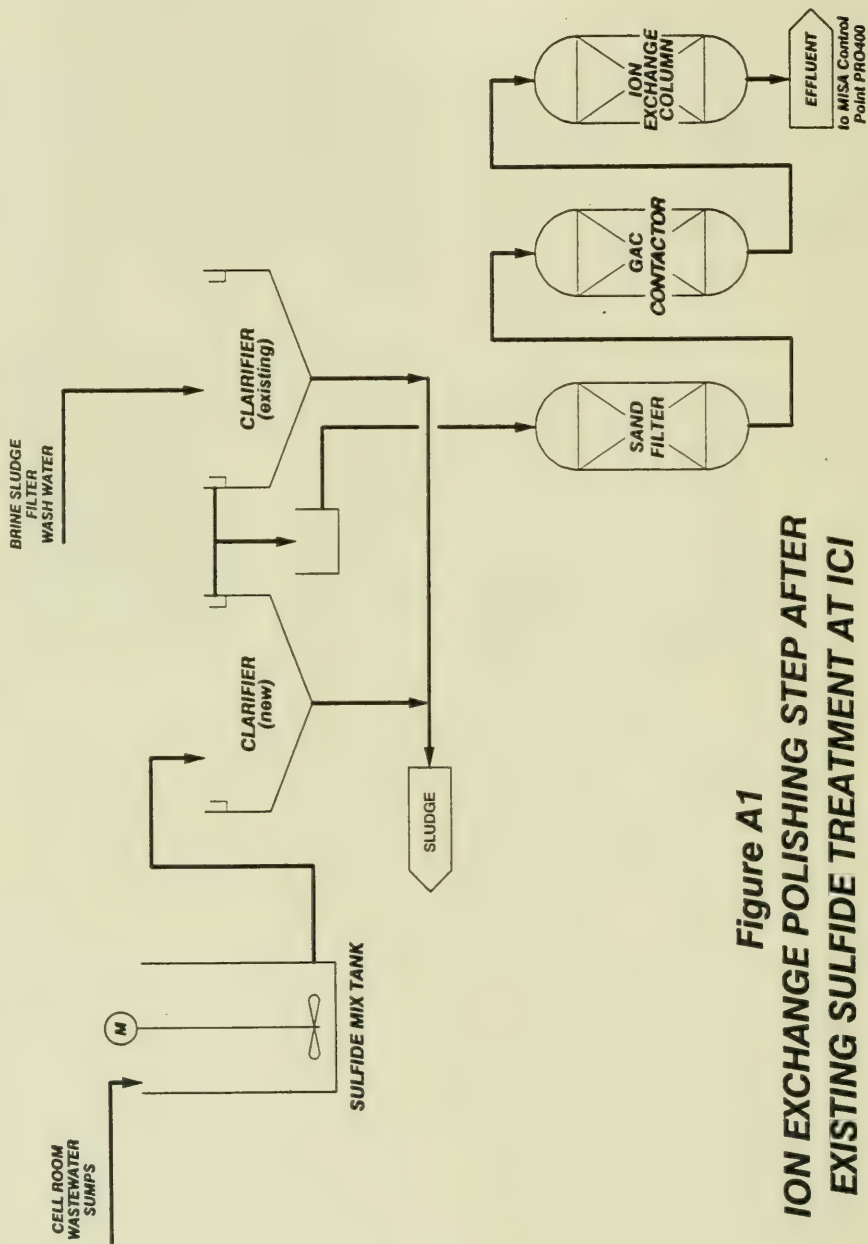
MISA Control Point: IN-0200

Description: Intake

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
Nitrate and Nitrite	mg/L	0.16	0.94	0.37
DOC	mg/L	1.9	6.5	3.8
Specific Conductance	uS/cm	157	283	229
Aluminum	ug/L	27	155	81
Beryllium	ug/L	12	14	12.2
Cadmium	ug/L	9		9
Copper	ug/L	13	66	17
Molybdenum	ug/L	32	32	32
Thallium	ug/L	33	33	33
Vanadium	ug/L	67	67	67
Zinc	ug/L	10	36	14.4
Phenolics (4AAP)	ug/L	2	3.5	2.4
Dibromochloromethane	ug/L	0.4	2.2	0.93
Chloroform	ug/L	4.1	11.7	7.8
Hexachlorocyclopentadiene	ng/L	17	17	17
1,2,3-Trichlorobenzene	ng/L	2	37.5	11.3
Chloride, Unfiltered Reactive	mg/L	21.4	31	23.6
Sulphate, Unfiltered Reactive	mg/L	24.3	30	26.6

**Table A4**  
**Toxicity Data for ICI (Cornwall) for the First Six Months of MISA**  
**Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow Trout	6	non-lethal	6
<u>Daphnia magna</u>	3	non-lethal	3



**Figure A1**  
**ION EXCHANGE POLISHING STEP AFTER**  
**EXISTING SULFIDE TREATMENT AT ICI**



ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS				LOADINGS			
				PR 0400	CO 0300	IN 0200		PR 0400	CO 0300	IN 0200	
c	Total suspended solids	5	mg/L	603	47.7	4.9		153	197	19.7	
c	Hydrogen ion (pH)			8.76	7.9	7.95					
c	Specific conductance		uS/cm	19700	3050	229					
c	DOC	0.5	mg/L	11.7	3.89	3.8		2.42	16	15.3	
c	TOC	5	mg/L	14.2	5.23	0.5		3.06	22.4	2.01	
c	Oil and grease	1	mg/L	9.15	1.75	0.9		1.9	6.76	3.61	
c	Ammonia, plus Ammonium Nitrate + Nitrite	0.25	mg/L	0.123	0.155	0.15		0.025	0.66	0.602	
c	Total Kjeldahl nitrogen	0.5	mg/L	0.52	0.468	0.391		0.115	7.84	1.48	
c	Total phosphorus	0.1	mg/L	0.715	0.2	0.038		0.163	0.801	0.153	
09	Aluminum	30	ug/L	505	147	60.8		0.103	0.634	0.324	
09	Beryllium	10	ug/L	8.32	2.73	12.2		0.001	0.01	0.049	
09	Boron	50	ug/L	735	227			0.156	0.997		
09	Cadmium	2	ug/L	1.18	8.32	9		—	0.032	0.036	
09	Chromium	20	ug/L	25.8	20.8	19.1		0.004	0.079	0.077	
09	Cobalt	20	ug/L	15.9	5.87	18.5		0.002	0.023	0.074	
09	Copper	10	ug/L	26.4	20.1	16.9		0.005	0.082	0.068	
09	Lead	30	ug/L	150	47.2	21.7		0.036	0.178	0.087	
09	Molybdenum	20	ug/L	22.2	11.6	32		0.004	0.046	0.128	
09	Nickel	20	ug/L	26	9.69	13.2		0.005	0.037	0.053	
09	Strontium	20	ug/L	3660	3240			1.03	14.3		
09	Thallium	30	ug/L	38.8	22.1	33		0.008	0.097	0.132	
09	Vanadium	30	ug/L	67.7	22	67		0.019	0.106	0.269	
09	Zinc	10	ug/L	97	29.2	14.5		0.020	0.111	0.058	
10	Arsenic	5	ug/L	7.5	2.79	3		0.002	0.012	0.012	
11	Chromium (hexavalent)	10	ug/L	10	8.3	3		0.002	0.032		
12	Mercury	0.1	ug/L	139	16.8	0.354		0.021	0.063	0.001	
14	Phenolics (4AAP)	2	ug/L	4.54	3.64	2.39		0.001	0.014	0.01	
15	Sulphide	20	ug/L	11.3	215	10		0.003	0.79	0.04	
16	1,2-Dichloroethane	0.8	ug/L	0.995	0.563	0.517		—	0.002	0.002	
16	Chloroform	0.7	ug/L	19.3	10.6	7.81		0.004	0.044	0.031	
16	Dibromochloromethane	1.1	ug/L	2.7	0.91	0.933		0.001	0.004	0.004	
16	Methylene chloride	1.3	ug/L	4.56	4.29	0.744		0.001	0.016	0.003	
16	Tetrachloroethylene	1.1	ug/L	1.8	0.446	0.4		—	0.002	0.002	
17	Benzene	0.5	ug/L	0.585	0.833	0.14		—	0.004	0.001	
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	6.38	2.98			0.002	0.012		
19	Di-n-butyl phthalate	3.8	ug/L	4.41	3.84			0.001	0.015		

Continued

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS				LOADINGS			
				PR 0400	CO 0300	IN 0200		PR 0400	CO 0300	IN 0200	
23	1,2,3,4 - Tetrachlorobenzene	10	ng/L	18.3	8.01	10		-	-	-	
23	1,2,3,5 - Tetrachlorobenzene	10	ng/L	8.63	2.93	3		-	-	-	
23	1,2,3 - Trichlorobenzene	10	ng/L	23.6	10.6	11.3		-	-	-	
23	1,2,4,5 - Tetrachlorobenzene	10	ng/L	13.1	3.85	3		-	-	-	
23	1,2,4 - Trichlorobenzene	10	ng/L	294	79	3		-	-	-	
23	2,4,5 - Trichlorotoluene	10	ng/L	33.6	4.4	3		-	-	-	
23	Hexachlorobenzene	10	ng/L	136	111	3		-	-	-	
23	Hexachlorobutadiene	10	ng/L	249	167	5		-	-	-	
23	Hexachlorocyclopentadiene	10	ng/L	39.1	15.1	17		-	-	-	
23	Hexachloroethane	10	ng/L	949	1670	3.17		-	0.007	-	
23	Octachlorostyrene	10	ng/L	56.2	15.8	6.92		-	-	-	
23	Pentachlorobenzene	10	ng/L	80.8	14.5	4		-	-	-	
24	Octachlorodibenzofuran	30	pg/L	761	113			-	-	-	
24	Total H6CDD	30	pg/L	59.6	22			-	-	-	
24	Total H6CDF	20	pg/L	1210	206			-	-	-	
24	Total H7CDF	30	pg/L	1140	20			-	-	-	
24	Total PCDD	20	pg/L	476	26.8			-	-	-	
24	Total PCDF	15	pg/L	2900	674			-	-	-	
24	Total TCDD	20	pg/L	74.7	17			-	-	-	
24	Total TCDF	15	pg/L	7620	997			-	-	-	
2	Cyanide Total	0.005	mg/L	0.392	0.077			0.058	0.237		
27	PCBT	0.1	ug/L	0.306	0.077			-	-	-	
98	Flow	m3/d		229	4010			-	-	-	
11	Chloride	2	mg/L	16900	1050	23.6		3690	3940	94.8	
12	Fluoride	0.1	mg/L	1.31	1.12			0.323	4.90		
13	Sulphate	5	mg/L	1310	297	26.6		294	1200	107	

Notes

PR0400 is the "Effluent in Manhole #15" and this flows into CO0300.  
CO0300 is the "Effluent in LEL-2" and this discharges to the St. Lawrence River.

Intake loadings are based on municipal intake analyses and the mean discharge flow from CO0300.  
Intake loadings are probable upper bounds because of substantial rainfall contributions to the flow.

## **APPENDIX 12**

**ICI Nitrogen Products, Lambton Works**



# **ONTARIO INORGANIC CHEMICAL SECTOR PLANTS**

## **REPORT ON BAT OPTIONS**

### **ICI NITROGEN PRODUCTS, LAMBTON WORKS**

#### **1.0 PLANT DESCRIPTION**

The ICI Nitrogen Products, Lambton Works plant manufactures anhydrous ammonia, urea, sulphur coated urea, ammonium nitrate, ammonium nitrate prills, nitrogen solutions and liquified carbon dioxide.

The plant uses intake water from the St. Clair River for once through non-contact cooling, cooling tower make-up water, wash water, barometric condenser cooling water and boiler feed water. Boiler feed water is demineralized in an ion-exchange treatment system prior to use. Water treatment chemicals are added to boiler feed water and cooling tower make-up water.

Details on the plant processes and wastewater management are presented in the site visit report (Ref. 1).

#### **2.0 WASTEWATER SOURCES AND QUALITY**

##### **2.1 Wastewater Sources**

Sources of process wastewaters generated in the various manufacturing processes include:

- Steam condensate from the ammonia plant that has been treated in a steam stripper.
- Cooling water from the barometric condenser used to condense contaminated water vapour produced in the ammonia nitrate production unit.
- Wash water used to clean a clay bin in the ammonium nitrate prills unit.
- Other minor sources that are generated on an irregular basis, such as spills, leaks, and leakage into once through cooling water systems.

Discharges are also generated at the plant from a number of non-process related sources, including:

- Non-contact steam condensates.
- Once through non-contact cooling water.



- Cooling tower blowdown.
- Boiler blowdown.
- Raw water ion exchanger regeneration wastewater that has been neutralized.

Table 1 presents the sources of discharges monitored under the MISA Monitoring Regulation at the following Control Points:

- PR0300
- CO0500
- OT0600
- CO0700
- CO0800
- OT1100
- OT1200

<b>Table 1</b> <b>Discharge Sources at ICI Nitrogen Products, Lambton Works</b>			
<b>Manufacturing Unit</b>	<b>Wastewater Source</b>	<b>Flow Rate m<sup>3</sup>/d</b>	<b>Destination</b>
Ammonia 2 and Argon Plant	Steam condensate (treated in a steam stripper)	326	CO0800
	Cooling tower blowdown	480	CO0500
	Neutralized ion exchanger regeneration wastes	65	CO0800
	Once through non-contact cooling water from Argon Plant	10,500	CO0800
Nitric Acid Plant	Once through non-contact cooling water from absorption tower and compressors	not provided	CO0700
	Boiler blowdown	not provided	CO0700
Urea Liquor 1	Steam condensate (non-contact)	288	CO0700
	Once through non-contact cooling water	13,000	CO0700
Urea Liquor 2	Steam condensate (non-contact)	525	CO0700
	Once through non-contact cooling water	30,000	OT0600
Ammonium Nitrate Liquor and Nitrogen Solutions	Contact cooling water from barometric condenser	4,400	PR0300
	Once through non-contact cooling water	550	CO0500
Ammonium Nitrate Prills	Steam condensate (non-contact)	180	CO0500
	Washdown of clay bin	39	PR0300
Ammonia Storage	Once through non-contact cooling water from compressor cooling	9,000	OT1200

In addition, all of the plant effluents, including storm water from process areas, are combined for final discharge, and were monitored at Control Point CO0200. Storm water runoff from most contaminated site areas is collected in a basin and are bled into the final effluent stream prior to the monitoring point.

## 2.2 Wastewater Flow and Quality

Tables A1 to A8 present average, maximum and minimum flow and concentration data for those parameters considered to be "Priority 1" by the Ministry of the Environment for the MISA Control Points at ICI Lambton Works. Table A9 presents intake water quality data.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following subsections.

### **3.1 BAT Option 1**

Toxicity data collected and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Table A10. Tests on samples of the final effluent from Control Point CO0200 were carried out on rainbow trout and Daphnia magna. Results from seven rainbow trout tests showed the samples were non-lethal, while two of three tests on Daphnia magna also produced non-lethal results. The lethal concentrations for the third test was >100 percent.

The data shows that the existing wastewater management system produces an effluent which is essentially non-lethal, and therefore, no changes to the existing system were included under BAT Option 1.

### **3.2 BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), Part 418 Fertilizer Manufacturing, limits were defined based on BAT for discharges from the manufacturing of ammonia, nitric acid, urea and ammonium nitrate. These are presented in Table 2. A discussion of each category compared to U.S. BAT is presented below.

#### **Ammonia Manufacturing**

The technology basis for the development of U.S. BAT effluent guidelines was the treatment of condensate produced in the process by steam stripping followed by high flow air stripping or biological nitrification (Ref. 2, Ref. 3). ICI has recently implemented steam stripping of this condensate. The stripper was not operating for approximately one month during the MISA monitoring period. However, a comparison of the effluent quality from the plant over the 12 months of monitoring in Table 3 shows that effluents did meet U.S. BAT limits. Therefore, no changes to the ammonia plant wastewater treatment system are recommended for BAT Option 2.

It is important to note that ammonia discharges to the atmosphere as a result of steam stripping or air stripping were not addressed in the U.S. Development Document (Ref. 2).

**Table 2**  
**U.S. BAT Effluent Limits For Nitrogen Fertilizer Manufacturing**

	U.S. Effluent Limits	
	Maximum Day	Average Day
<b>Ammonia Manufacturing</b>		
Ammonia - N (kg/t/d) <sup>1</sup>	0.05	0.025
pH	6.0-9.0	6.0-9.0
<b>Urea Manufacturing</b>		
Ammonia - N (kg/t/d)	0.95	0.48
Organic - N (kg/t/d)	0.61	0.33
<b>Ammonium Nitrate Manufacturing</b>		
Ammonia - N (kg/t/d)	0.08	0.04
Nitrate - N (kg/t/d)	0.12	0.07
<b>Nitric Acid Manufacturing</b>		
Ammonia - N (kg/t/d)	0.0045	0.00045
Nitrate - N (kg/t/d)	0.17	0.023
Notes:		
1. Kilogram of contaminant per tonne of production capacity per day.		

**Table 3**  
**Comparison of U.S. BAT Effluent Limits for Ammonia Manufacturing  
To Effluent Loadings at ICI**

Parameter	U.S. BAT		MISA Monitoring Period <sup>1</sup>	
	Maximum Day	30 Day Average	Maximum Day	12 Month Average
Ammonia - N (kg/d) <sup>2</sup>	225	75	52 <sup>3</sup>	41
pH	6.0-9.0	6.0-9.0	6.4-9.0	7.8
Notes:				
1. Data from MISA Control Point 0800, includes steam stripper effluents, once through cooling water and ion exchanger regeneration water.				
2. Calculated using ammonia production capacity at ICI.				
3. Calculated from maximum concentration and average flow data.				

### Nitric Acid Manufacturing

The best practicable control technology (BPT) for the control of wastewater generated in the production of nitric acid was defined as containment (Ref. 2). Leaks and spills were considered controllable, and reusable in other areas of a nitrogen fertilizer complex. Despite this observation, BAT limits were established for effluents from nitric acid production, excluding non-process waters, as shown in Table 2.



There are no routine process related discharges from the production of nitric acid at ICI, Lambton Works. Wash water and spills from this areas are reused in the production of liquid nitrogen products. Therefore, no changes to the existing nitric acid wastewater management system are recommended in BAT Option 2 for the plant.

### Ammonium Nitrate

The U.S. Development Document (Ref. 2) recommended that BAT effluent limits in the ammonium nitrate subcategory could be achieved with leak control, spill control and good housekeeping. Reduction of contaminants in process condensates could be achieved through reuse of the condensate as absorber feed in the nitric acid plant.

At the ICI plant, routinely generated wash water, spills etc. are not discharged with the exception of wash water from a clay bin, as they are reused in the production of nitrogen solutions. A barometric condenser is used to condense steam from the ammonium nitrate evaporators.

Table 4 compares U.S. BAT effluent limits to the quality of wastewater produced from the manufacture of ammonium nitrate prills and ammonium nitrate liquor. U.S. limits are not currently being met by ICI.

<p align="center"><b>Table 4</b>  <b>Comparison of U.S. BAT Effluent Limits to Process Effluent Quality</b>  <b>From the Ammonium Nitrate Production Unit of ICI</b></p>				
Parameter	U.S. BAT		MISA Monitoring Period <sup>1</sup>	
	Maximum Day	30 Day Average	Maximum Day	12 Month Mean
Ammonia - N (kg/d) <sup>2</sup>	78.4	39.2	951.3 <sup>3</sup>	118.5
Nitrate - N (kg/d) <sup>2</sup>	117.6	68.6	1,224 <sup>3</sup>	135.6
<p>Notes:</p> <p>1. Based on data from MISA Control Points PR0300 and CO0500.</p> <p>2. Calculated using ammonium nitrate production capacity at ICI.</p> <p>3. Based on maximum concentration and mean flow.</p>				

They would, however, be met if the barometric condenser stream, and the washdown water for the clay bin, contributing a total of 97 kg/d of ammonia (as measured at PR0300), were not discharged. The following methods for eliminating these discharges are currently being considered by ICI:

- Replacing the barometric condenser with a surface condenser, and re-using the small volume of concentrated condensate in the production of products.



- Evaluating water use in the clay bin washing operation, and either eliminating water use or reusing water in the production of products.

The above mentioned technologies for eliminating effluents measured at PR0300 from plant discharges were include in BAT Option 2, to meet U.S. BAT effluent limits. These are discussed in detail in Section 4.0.

## Urea Manufacturing

At ICI, process wastewaters such as condensates and washwaters are for the most part collected and reused in the production of liquid nitrogen solutions. Therefore, on a technology basis, the fact that there are no discharges from this unit, indicates more advanced wastewater control than U.S. BAT. Contamination of non-process effluents generated in this area.

Table 5 compares total effluents loadings of contaminants produced in the two urea units with U.S. BAT limits. The comparison shows that the average contaminant loading was significantly less than U.S. BAT limits on an average basis. The maximum estimated loading of ammonia at ICI is higher than the U.S. BAT limit. However, the frequency of exceedances over the twelve month monitoring period is unknown and therefore, no firm conclusion can be made. It is recommended that these high loading occurrences be evaluated to determine their significance. However, based on the available data, it appears that U.S. BAT limits are generally achieved at ICI.

**Table 5**  
**Comparison of U.S. BAT Effluent Limits to Process Effluent**  
**Quality from the Urea Plants at ICI**

Parameter	U.S. BAT		MISA Monitoring Period <sup>1</sup>	
	Maximum Day	30 Day Average	Maximum Day	12 Month Average
Ammonia (kg/d) <sup>2</sup>	244	124	3,956 <sup>4</sup>	62
Organic - N (kg/d) <sup>3</sup>	207	110	no data	78
Notes:				
1. Based on data from MISA Control Point CO0700, and OT0600.				
2. Calculated from urea production capacity at ICI.				
3. Calculated as TKN minus ammonia - nitrogen.				
4. Based on maximum concentration and mean flow.				

## Summary

A review of U.S. BAT limitations relative to the wastewater discharge at ICI was presented to identify technologies that should be included in BAT Option 2. Target

contaminant loadings in effluents from the ammonia, urea and nitric acid production areas were well below those prescribed under U.S. BAT. It is important to note that loadings generated at ICI which were compared to U.S. BAT also included those contributions from non-process waters (e.g. cooling tower blowdown and once through cooling water), which were excluded from the U.S. EPA requirements (i.e. U.S. BAT covered only process wastewater). Based on the review, BAT Option 2 incorporates the existing technologies in the ammonia, urea and nitric acid production plants.

In the ammonium nitrate plant, BAT limits are not currently achieved at ICI. Thus, technologies to eliminate the barometric condenser stream and the clay bin washdown water stream are included in BAT Option 2. These technologies are discussed in detail in Section 4.0.

### **3.3            BAT Option 3**

There are two nitrogen fertilizer plants in the Ontario Inorganic Chemical Sector, including ICI Lambton Works and Nitrochem Inc., whose wastewater management can be compared on the basis of technologies and effluent quality (Ref. 1, Ref. 4).

#### **Technology**

Both Ontario plants incorporate collection and reuse of process wastewater, including condensates and wash water, into liquid nitrogen fertilizer products. Thus, with the exception of select streams at both plants, process effluents are not discharged.

Different technologies for manufacturing nitrogen fertilizer products are used at each plant. However, in terms of wastewater control, the same overall results are achieved; that is reuse of wastewater discharges. Therefore, based on technologies alone, one process can not be considered more advanced than the other.

#### **Effluent Quality**

A direct comparison of effluent quality at ICI and Nitrochem cannot be made, for the following reasons:

- Product lines and production capacities vary significantly between the two plants.
- Data for effluents from individual production units were not available for Nitrochem.

- Concentration data may not be compared directly because ICI incorporates a significant volume of once through cooling water which dilutes effluents, while Nitrochem does not.
- Contaminant loadings from the two plants are not significantly different from each other.

Therefore, observations in best demonstrated technologies may not be made on the basis of effluent quality.

### **Summary**

There is no clear indication as to which plant can be considered to be representing the best in the Province for wastewater control technology. Both plants are managing water to minimize process discharges, although certain streams are discharged directly with or without treatment at both plants. Effluent quality in terms of loadings are not different by a significant factor, and since production capacities vary between the plants, it is difficult to draw a conclusion on this basis.

For the purposes of BAT Option 3, both Ontario nitrogen fertilizer plants are considered equivalent in terms of wastewater management, and therefore no changes to the ICI system are included in this Option.

## **3.4            BAT Option 4**

BAT Option 4 includes technologies which provide the maximum overall pollution reduction at the plant. These technologies are discussed below under the following headings:

- Process stream treatment or elimination.
- In plant water management.
- Control of monitored effluents.

### **3.4.1            Process Stream Treatment or Elimination**

Only three process wastewater streams generated at ICI are discharged, since the remainder are collected and reused in nitrogen products.

Methods for eliminating the barometric condenser stream and wash water for the clay bin discussed in Section 3.3, would also be included in BAT Option 4.

An ammonia process steam condensate generated at a rate of 326 m<sup>3</sup>/d is currently treated by steam stripping, which produces an effluent concentration of 11.5 mg/L ammonia-N (Ref. 7).

A global search identified several technologies that were potentially applicable to further reducing ammonia concentrations in steam stripper effluents. These are:

- Ion exchange
- Break point chlorination
- Air stripping
- Biological nitrification-denitrification.

### Air Stripping

Air stripping was recommended by the U.S. EPA (Ref. 2) to follow steam stripping to achieve U.S. BAT effluent limits. This reference reported that better than 90 percent ammonia removal was achievable resulting in effluent concentrations of less than 5 mg/L. A global search of technologies used in the ammonia manufacturing industry did not identify plants using air stripping. In the U.S., in 1979, no air strippers were known to be operating or planned at nitrogen fertilizer facilities (Ref. 5).

The air stripping process involves raising the pH of the water to 10.8 to 11.5 with lime to convert all ammonia to ammonium, formation and reformation of water droplets in a stripping tower, and providing air water contact and droplet agitation to enable transfer of ammonia to air, which is released to the atmosphere.

Several problems associated with air stripping have been identified as follows (Ref. 2, 5, 6):

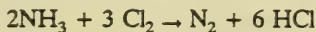
- Low performance efficiencies in cold weather.
- High operating costs because of intense energy requirements.
- Calcium carbonate scaling as a result of lime addition.
- Cross media pollutant transfer; the ammonia is released to the atmosphere. Although technologies for ammonia recovery from air exist, they considerably increase the complexity and cost of the system.

On the basis of the above points, air stripping was not considered to be a demonstrated, practical control technology for treating the ICI ammonia plant steam stripper effluent stream.



## **Breakpoint Chlorination**

Breakpoint chlorination is the oxidation of ammonia with chlorine to result in the ultimate formation of nitrogen gas, following the overall reaction:



Theoretically, 7.6 mg/L of chlorine ( $\text{Cl}_2$ ) are required to oxidize 1 mg/L of ammonia-nitrogen.

Breakpoint chlorination has a long history of use in the chlorination of potable water supplies. It has also been used in the U.S. for minimizing the levels of unionized ammonia in effluents from other nitrogen removal technologies. However, several problems are potentially associated with the use of this technology in industrial wastewater treatment, including:

- Nitrate and nitrogen trichloride may be produced in the breakpoint chlorination reactions. Nitrate is another pollutant at nitrogen fertilizer facilities, while nitrogen trichloride exhibits a strong chlorinous odour, making its formation undesirable.
- Trihalomethanes and other chlorinated pollutants may be formed.
- Total dissolved solids levels may increase.
- Neutralization may be required to increase the pH after treatment. In addition, a dechlorination process to remove toxic chlorine residuals is required. Additional treatment steps increase the complexity of the system.
- Control of pH is critical to the performance of the process and to minimize nitrogen trichloride formation. Changing water quality makes pH control difficult. Thus, reliability decreases during plant upsets.

In a global search, the use of breakpoint chlorination for reducing ammonia in nitrogen fertilizer plant effluents was not identified, nor was it recommended in the U.S. to achieve BAT effluent limits. Based on the above potential problems associated with breakpoint chlorination, it is not a recommended technology for reducing ammonia levels in ICI Lambton Works ammonia plant effluents.

## **Ion Exchange**

Selective ion exchange is a high-efficiency ammonia removal process for streams containing low TDS and ammonia concentrations. The waste stream is passed through a bed of ion exchange resin and functional groups attached to the resin exchange with



ammonium ions in solution. Conventional ion exchange resins are not suitable for ammonia removal because most ions exchange preferentially to the ammonium ion. However, this limitation is overcome by using an exchange resin selective for ammonium, such as clinoptilolite, a common material found in bentonite deposits which removes ammonium ions from water preferentially to other cations.

The optimum exchange pH ranges from 4 to 8. Lower values result in excess hydrogen ions competing with the  $\text{NH}_4^+$  for exchange. At a high pH,  $\text{NH}_4^+$  is predominantly converted to  $\text{NH}_3$  which will not exchange on the media. The process is insensitive to temperature fluctuations, but becomes less effective as ionic strength (TDS concentration) increases due to the effect of competing cation concentrations on the capacity of the media for ammonium (Ref. 8).

The exchange column can be regenerated with a sodium or calcium salt solution and the nitrogen can be recovered from the regenerant by air stripping, steam stripping, or electrolytic treatment.

Reported applications of selective ion exchange for ammonia removal include the treatment of municipal wastewaters having ammonia concentrations of about 25 mg/L. The U.S. EPA suggested ion exchange as an alternative treatment process to achieving BAT effluent limits in the nitrogen fertilizer industry (Ref. 2). In the global search carried out for this study, it was found that ion exchange was implemented in the 1970s at more than 10 nitrogen fertilizer facilities. However, currently only one process is remaining in operating. Operating problems that were encountered resulted in the discontinued use of this process<sup>2</sup> (Ref. 9). Based on these problems, this process is not recommended under BAT Option 4 for ICI.

### **Biological Ammonia Removal**

Biological ammonia removal is the natural conversion of ammonia to nitrate, and nitrate to molecular nitrogen in a two stage process. The first stage, nitrification, takes place under aerobic conditions, while the second stage denitrification is anoxic, and must have a carbon source (typically methanol). Both suspended growth and fixed film systems are available. Details on the process are provided in a general technology report (Ref. 10).

Biological ammonia removal has been applied to treating ammonia nitrogen levels in industrial wastewaters with 30 to 700 mg/L (Ref. 10). One fertilizer industry in the U.S. uses an anaerobic and aerobic lagoon system to reduce nitrogen levels from 150 to 200 mg/L by up to 98 percent (Ref. 11).

---

<sup>2</sup>

Details on operating problems collected by SAIC are currently unavailable.

Nitrification has been shown to reduce dilute ammonia levels in municipal wastewater of 10 mg/L or more, in an activated sludge system. However, a global search did not identify demonstrated industrial uses of this system for treating dilute ammonia wastewaters, such as the ICI steam stripper effluent streams. Therefore, biological nitrogen removal was not considered an alternative for treating this stream.

### **Summary**

Four potential alternatives for reducing ammonia levels in the treated ammonia plant condensate stream at ICI were identified in a global search. Based on review of information on these processes, none were considered applicable, due to operating problems associated with treatment, or their unproven ability to treat industrial wastewater streams with similar characteristics. Therefore, technologies for further reduction of ammonia in this stream were not recommended under BAT Option 4.

It should be noted that the treated ammonia condensate stream may contain other process related contaminants. However, individual monitoring data of this stream for contaminants other than ammonia is not available. Therefore, methods for their reduction cannot be addressed.

### **3.4.2      In-Plant Water Management**

A global search of nitrogen fertilizer manufacturing facilities found that wastewater management is considered the key to reducing the levels of contaminants in effluents. Techniques include good house-keeping, reduction and/or reuse of process water streams, and audit and control of miscellaneous contaminant sources such as leaks and spills.

Contacts and visits made with nitrogen fertilizer facilities in Canada and U.S. indicated that collection of high strength process wastewaters for reuse in production of fertilizer products is a very common means of reducing effluent discharges (Ref. 4, 12, 13). Handling of other sources are very site specific, depending on the design, layout and age of the facility, and the products generated.

ICI Nitrogen Products made considerable improvements to their effluent quality in the past few years by implementation of in-plant changes for reuse of process effluents, and clean-up of miscellaneous streams, following an audit of nitrogen sources carried out at the plant in 1989 (Ref. 14). These changes have resulted in a total reduction of ammonia nitrogen loading from the plant by about 80 percent<sup>3</sup>. Elimination of the process streams still being discharged, as discussed in Section 3.4.1, will further reduce the loading by about half.

---

<sup>3</sup> Since the 1989 study, the Ammonia 1 plant has shut down.

Representatives from ICI indicate that continuing efforts are being made to investigate other sources of contamination so that these may also be diverted from discharges. These continuing procedures are incorporated onto the recommended BAT Option 4. However, the details of changes, costs and expected performance cannot be determined until the sources of contamination and remediation methods have been investigated, identified, and implemented. Some key areas of focus are summarized in the discussion of BAT Option 4 in Section 4.

### 3.4.3 Control of Monitored Streams

Control and treatment of pollutant to be achieve a maximum reduction was considered for combined streams (CO0500, CO0700 and CO0800), once through cooling water streams (OT0600, OT1100 and OT100), and final plant effluent stream (CO0200).

All of the above streams showed dilute, similar levels of contaminants such as DOC, TOC, aluminium, strontium, zinc, chloride and sulphate, which were likely contributed from the raw water source, since levels are similar to those in raw water, presented in Table A8.

Technologies for the removal of low levels of contaminants present in these effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

Non-raw water related contaminants identified as "Priority 1" in each stream and in the final effluent are summarized in Table 6.

Levels of ammonia, TKN and nitrate nitrogen did not exceed 3.5 mg/L on average in any of the monitored streams. Based on a review of ammonia removal technologies presented in Section 3.4.2 practical technologies for further removal of ammonia were not identified. Furthermore, a global search did not identify demonstrated technologies for removing dilute levels of organic nitrogen or nitrate from industrial wastewaters. Therefore, end-of-pipe wastewater treatment for these contaminants is not recommended for any of these streams.

Some of the phosphorus in effluents may originate from phosphate based chemicals used to treat cooling tower make-up water, since phosphorus was detected at CO0500, which included cooling tower blowdown. Reduction of phosphorus levels could be achieved by using alternate treatment chemicals. However, because these would also contribute contaminants to the effluents, there may not be an overall improvement in water quality. Because phosphorus levels are very low, and a change in water treatment chemicals would be of questionable benefit, no changes are recommended to reduce phosphorus in effluents.



<p style="text-align: center;"><b>Table 6</b>  <b>Priority Contaminants in Combined and Final Effluent Streams</b></p>					
Contaminant	CO0200 Final	CO0500	CO0700	CO0800	OT0600, OT1100, OT1200
Ammonia-N	•	•	•	•	
TKN	•	•	•	•	
Nitrate and Nitrite	•	•	•	•	
Phosphorus	•	•			
TSS	•	•	•	•	•
Cyanide		•			
Phenolics		•	•	•	
Phenol			•		
Chloromethane		•			
Chloroform		•			

Chloromethane and chloroform were contaminants present in the stream monitored at CO0500, containing cooling tower blowdown. The cooling tower make-up water is chlorinated, and this is a likely source of chlorinated organic compounds. One alternative that can be considered to reduce the levels of these compounds is use of an alternate biocide. This technology is described in the general technology report (Ref. 15). Since neither of these compounds were detected in final effluents from the plant (at CO0200) and the plant effluents were non-lethal (indicating chlorine residuals are not at toxic levels), changes to the system were not recommended under BAT Option 4.

Phenols were present in all combined effluent streams discharged from the plant, and in one stream, phenol was also detected. Monitoring data indicates that a portion of phenolics are present in raw water. Heat exchange coolants or equipment lubricants are potential sources of phenols in effluents. However, an audit is recommended to investigate and confirm these sources, and to identify management practices for their control at the source. These procedures are included under BAT Option 4. It is noteworthy that phenolics were not a "Priority 1" pollutant in the final plant effluent, despite their presence in raw water.

Suspended solids were present at low levels (<13 mg/L) in all in-plant monitored streams and in the final effluent (<6 mg/L). Technologies for further reducing suspended solids levels include coagulation and sedimentation, and filtration. However, implementation of several treatment processes would also produce related problems which would need to must be addressed, including:

- The impacts of wastewater treatment chemicals on effluents, in term of contaminant concentrations and toxicity.

- The handling and disposal of wastewater treatment residuals.
- The dependence of system reliability and operator training on performance.

Because of these problems, coupled with the fact that TSS do not appear to be contributing toxic contaminants to plant effluents, treatment processes for their removal are not recommended.

One contaminant, cyanide, present in the stream monitored at CO0500 was not addressed in the discussion of BAT Option 4. Careful review of the process, raw materials, products and chemicals used at the plant within the scope of this study did not reveal a source of this contaminant. Thus, an audit of possible cyanide sources is necessary, and reduction or elimination of this contaminant in discharges should be based on process changes, materials substitution, or other best management practices.

#### **3.4.4      Summary of BAT Option 4 Recommendations**

Technologies for the maximum reduction of contaminants recommended under BAT Option 4 include:

- Elimination of the barometric condenser and clay bin wash water streams measured at PR0300, as described under BAT Option 2.
- Continued investigation and implementation of in-plant controls and best management practices to reduce undefined process related discharges such as leaks and spills.
- In-plant management practices for source control of phenols.

#### **3.5      BAT Option 5**

Technologies that would advance the plant furthest toward zero-discharge of process related contaminants include all those recommended under BAT Option 4. Technologies for reduction or elimination of non-process streams such as boiler blowdown, cooling tower blowdown and once through cooling water were not identified in a global search.

Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool process equipment in all manufacturing sectors including the nitrogen fertilizer industry. Other cooling methods, such closed-loop air cooled systems, would require very large capital expenditures and land area for expansive heat



exchange equipment requirements, and may not be effective in warmer months in Ontario. Thus, this approach to cooling is not used in the industry. And finally, opportunities for consumption of cooling tower blowdown or condensate to not appear to exist in the production of any of the products produced at ICI, since these are already consuming process effluents.

### 3.5 Summary

Table 7 presents a summary of BAT Options recommended for ICI Lambton Works.

<p align="center"><b>Table 7</b> <b>Summary of BAT Options for ICI Lambton Works</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents.	No change to existing system.
2	U.S. BAT.	Elimination of barometric condenser and clay bin wash water streams.
3	Best demonstrated in Ontario.	No change to existing system.
4	Provides maximum pollution reduction.	Same as BAT Option 2 plus continued in plant modifications for elimination of miscellaneous process pollutant sources and management practices for control of phenols.
5	Furthest towards zero-discharge of pollutants.	Same as BAT Option 4.

## 4.0 BAT OPTIONS

BAT Options 1 and 3 recommended no change to the existing wastewater management strategy at ICI. BAT Option 2, 4 and 5 are described in more detail in the following sections.

### 4.1 BAT Option 2

#### Description

BAT Option 2 involves elimination of the process wastewater streams that were monitored at Control Point PR0300. Changes include:

- Replacement of the barometric condenser in the ammonium nitrate production unit and replacement with a surface condenser, and reuse of surface condenser condensate.

- Process change, or collection and reuse of clay bin wastewater in the ammonium nitrate prills area to eliminate its discharge.

The details of the surface condenser technology are described in the general technology report (Ref. 16). Either a tube and shell or plate type heat exchanger will be used to condense the steam containing process contaminants (ammonia and nitrate). The concentrated steam condensate could possibly be used in the production of liquid nitrogen fertilizer products, although other reuse areas are also being considered at ICI.

Technologies for eliminating the discharge of the clay bin wash water stream have not yet been investigated by ICI. They could include collection and reuse of the stream in products, minimizing water use or recycling water used for this purpose. Although as yet undefined, the plant has indicated that they believe opportunities for eliminating this process wastewater exist (Ref. 17).

### Performance

If BAT Option 2 were implemented, the combined process stream monitored at MISA Control Point PR0300 would be eliminated. The projected contaminant loading reductions that would result at the final effluent monitoring point are presented in Table 8.

### Cost

The costs of replacing the existing barometric condenser with a surface condenser were estimated to be \$257,000 (ENR CCI 6343), which includes (Ref. 16):

- Condenser with associated piping and instrumentation.
- Seal tank with attached condensate transfer pump.
- Engineering, installation and G.S.T.

The annual projected operating cost for this unit is \$30,000. These costs are conservative, since they do not include any savings incurred by the elimination of the barometric condenser.

Since the process changes required to eliminate the discharges of clay bin washwaters have not been identified by the plant, costs for these changes are also unavailable. Since it is a relatively small stream (39 m<sup>3</sup>/d) it is expected that capital expenditures would not be significant and operating costs should be small.

**Table 8**  
**Projected Contaminant Loading Reduction with Implementation of BAT Option 2**

Contaminant	Current Loading at CO0200 <sup>1</sup>	Projected Loading Reduction <sup>2</sup>	Projected Loading at CO0200	% Loading Reduction
Flow (m <sup>3</sup> /d)	168,000	3,590	164,410	2%
Ammonia-N (kg/d)	200	97.3	103	49%
TKN (kg/d)	345	130	215	38%
Nitrite and Nitrate-N (kg/d)	192	96.8	95.2	50%
DOC (kg/d)	464	40.5	423	9%
Total Phosphorus (kg/d)	11.3	1.7	9.6	15%
TSS (kg/d)	1,085	157	928	14%
Aluminum (kg/d)	16.0	1.8	13.2	11%
Strontium (kg/d)	17.3	0.59	16.7	3%
Chloride (kg/d)	1,426	95.4	1,331	7%
Sulphate (kg/d)	3,365	141.7	3,228	4%
Notes:				
1. Average contaminant loading reported for 12 months of MISA Monitoring Regulation period at CO0200.				
2. Average contaminant loading reported for 12 months of MISA Monitoring Regulation period at PR0300.				

## 4.2 BAT Option 4 and 5

BAT Options 4 and 5 include those technologies incorporated in BAT Option 2 in addition to continued efforts at the plant to minimize or eliminate miscellaneous contaminant discharges to sewers.

The complexity of the plant, and the fact that it was not originally built for minimization of contaminant discharges, dictate the difficulty in identifying and minimizing inadvertent discharge sources. Thus, the technologies for achieving the maximum reduction of pollutants from these sources cannot currently be precisely defined, nor can their cost or expected performance be quantified.

A general discussion of the sources and means of identifying and remediating these sources is presented in the following points:

- Cooling tower have been shown to act as absorbers of airborne ammonia at nitrogen fertilizer facilities, resulting in blowdown ammonia nitrogen concentrations of 5 to 100 mg/L (Ref. 2, 3). Options that could be considered for reducing levels of ammonia in blowdown include control of ammonia emissions from the plant.

- An audit of ammonia discharge sources has already been undertaken to identify major areas of discharge (Ref. 14). Further investigation has been and should continue to be carried to identify exact sources of discharge. Thus, methods for their elimination can be determined.
- In the U.S. Federal Register, Part 418 Fertilizer Manufacturing, non-contact cooling waters were only excluded from effluent limits regulation under the provision that all reasonable measures have been taken to control to the maximum extent possible contamination from process materials, and furthermore, that if contamination were to occur, all reasonable efforts would be taken to mitigate the effects. With respect to this requirement, identification of process contaminant leaks into coolers, etc. should be monitored routinely and repaired as required.

## 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 9 presents a summary of the estimated costs and performance, in terms of loading reduction, projected for the five BAT Options recommended for ICI Nitrogen Products Lambton Works.

<p align="center"><b>Table 9</b> <b>Summary of Costs and Performance of BAT Options</b></p>				
Component		BAT Option 1, 3	BAT Option 2	BAT Option 4, 5
Cost				
•	Capital	\$0	\$257,000	>\$257,000
•	Operating	\$0	\$30,000	>\$30,000
Performance		Loading Reduction		
Flow (m <sup>3</sup> /d)		0.0	3,590	>3,590
Ammonia-N (kg/d)		0.0	97.3	>97.3
TKN (kg/d)		0.0	130	>130
Nitrate-N (kg/d)		0.0	96.8	>96.8

## 6.0 REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report, ICI Nitrogen Products, Lambton Works. April 11, 1991 (unpublished).
2. Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Basic Fertilizer Chemicals Segment of the Fertilizer Manufacturing Point Source Category. U.S. EPA Report EPA - 440/1-74-001-a. March 1974.



3. Personal conversation with Dr. Thomas Fielding, U.S. EPA. March 1991. May 2 & 3, 1991 (unpublished).
4. Inorganic Chemical Sector Plants Site Visit Report, Nitrochem Inc.
5. An Evaluation of Control Needs for the Nitrogen Fertilizer Industry. U.S. EPA Report EPA-6-2-79-186. August 1979.
6. Process Design Manual for Nitrogen Control. U.S. EPA Technology Transfer. October 1975.
7. Information provided by ICI Nitrogen Products Lambton Works, October 1991.
8. J.H. Koon, W.J. Kaufmann. "Ammonia Removal from Wastewater by Ion Exchange", Journal of Water Pollution Control Federation, Vol. 47, pp. 448-465, 1975.
9. Telephone conversation with Irwin Higgins of Lake Industries Inc., Oak Ridge, Tennessee. July, 1991.
10. General Technology Report Biological Nitrogen Removal.
11. Telephone conversation with Roy Dugan of Air Products and Chemicals Inc., Pensacola. April 1991.
12. Inorganic Chemical Sector Global Study Site Visit Report-Simplot Canada Ltd.
13. Telephone conversation with Tom Carville of CF Chemicals, Inc., Donaldsonville, Louisiana.
14. Confidential Report by CH2M HILL ENGINEERING LTD. for ICI Lambton Works, 1989.
15. General Technology Report for Cooling Tower and Boiler Water Make-up Treatment Chemicals.
16. Plant Specific Technology Report-Surface Condenser for Ammonia Steam Condensation.
17. Telephone conversation with Bob Lalonde, of ICI Nitrogen Products, Lambton Works, October, 1991.





## **APPENDIX**

### **Tables**



**Table A1, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0200

Description: Final Discharge

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	17300	221000	168000	
COD	mg/L	10	29	19.5	3154.78
Ammonia Plus Ammonium	mg/L	0.56	2.44	1.17	199.56
Total Kjeldahl Nitrogen	mg/L	0.93	4.61	2	345.181
Nitrate and Nitrite	mg/L	0.51	1.77	1.13	192.248
DOC	mg/L			2.72	464.178
Total Phosphorus	mg/L	0.01	0.16	0.066	11.313
Specific Conductance	uS/cm	177	463	228	
Total Suspended Solids	mg/L	0.6	35.2	6.39	1085.222
Aluminum	ug/L	60	136	98	16.032
Strontium	ug/L	99	104	101.5	17.276
Chloride, Unfiltered Reactive	mg/L	7.56	9	8.28	1426.158
Sulphate, Unfiltered Reactive	mg/L	18.2	21.6	19.9	3365.118

**Table A2, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: PR0300

Description: Ditch After Emergency

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	97.6	24300	3590	
Cyanide Total	mg/L	0.005	0.02	0.011	0.042
Hydrogen Ion (pH)		7.65	10.03	8.818	
Ammonia Plus Ammonium	mg/L	2.79	172	26.341	97.327
Total Kjeldahl Nitrogen	mg/L	6.09	309	35.281	130.126
Nitrate and Nitrite	mg/L	3.55	232	44.8	96.75
DOC	mg/L	1.1	10.4	1.18	40.538
TOC	mg/L	0.01	2.08	1.281	43.065
Total Phosphorus	mg/L	0.01	2.08	0.36	1.748
Specific Conductance	uS/cm	203	2510	516	
Total Suspended Solids	mg/L	4.6	318	35	157.177
Aluminum	ug/L	46	1450	413	1.816
Copper	ug/L	1	27.5	9.4	0.046
Strontium	ug/L	100	230	133	0.585
Zinc	ug/L	2	15400	429	1.82
Phenolics (4AAP)	ug/L	0.8	15.4	6.5	0.028
Chloride, Unfiltered Reactive	mg/L	9	63.8	25.7	95.43
Fluoride, Unfiltered Reactive	mg/L	0.01	0.94	0.295	1.214
Sulphate, Unfiltered Reactive	mg/L	2	92	35	141.679



**Table A3, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0500

Description: 30 inches Concrete

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1344.8	35360.2	11110.88	
Cyanide Total	mg/L	0.005	0.01	0.007	0.072
Ammonia Plus Ammonium	mg/L	0.3	30.04	2.259	21.242
Total Kjeldahl Nitrogen	mg/L	0.6	65.23	3.264	31.16
Nitrate and Nitrite	mg/L	0.34	35.18	3.744	38.84
DOC	mg/L	0.6	14.7	3.212	35.308
Total Phosphorus	mg/L	0.01	0.932	0.214	2.114
Specific Conductance	uS/cm	192	1557.5	275.81	
Total Suspended Solids	mg/L	1.4	73.71	82.583	
Aluminum	ug/L	37	280	65.417	1.11
Strontium	ug/L	90	140	115	1.18
Zinc	ug/L	2.5	397	51.86	0.597
Phenolics (4AAP)	ug/L	0.8	240	30.85	0.302
Chloromethane	ug/L	0.37	33.8	6.627	0.062
Chloroform	ug/L	0.1	4.62	1.61	0.012
Chloride, Unfiltered Reactive	mg/L	8.5	14.5	12.225	137.421
Fluoride, Unfiltered Reactive	mg/L	0.01	0.29	0.122	1.247
Sulphate, Unfiltered Reactive	mg/L	4.67	48.2	21.756	223.531

**Table A4, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT0600

Description: 18" Black Polyethylene

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	10500	25500	17700	
Nitrate and Nitrite	mg/L	0.025	0.56	0.38	6.689
DOC	mg/L	0.8	16	1.8	33.665
Specific Conductance	uS/cm	163	253	218	
Total Suspended Solids	mg/L	4.6	9.6	5.9	92.537
Aluminum	ug/L	16	214	80	1.425
Strontium	ug/L	87	110	98	1.796
Zinc	ug/L	3	100	23	0.413
Sulphate, Unfiltered Reactive	mg/L	11.3	20.7	17.7	323.621

**Table A5, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants:

MISA Control Point: CO0700

Description: Manhole # 5

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	30700	68000	54500	
Ammonia Plus Ammonium	mg/L	0.025	73	1.31	60.301
Total Kjeldahl Nitrogen	mg/L	0.42	77	2.71	131.563
Nitrate and Nitrite	mg/L	0.025	23	1.31	43.014
DOC	mg/L	0.5	23.7	2.05	161.208
Specific Conductance	uS/cm	166	220	213	
Total Suspended Solids	mg/L	0.5	34	5.9	320.643
Aluminum	ug/L	35	164	90	5.03
Strontium	ug/L	80	110	99	5.589
Zinc	ug/L	1	81	23	1.271
Phenolics (4AAP)	ug/L	0.8	34	13.3	0.793
Phenol	ug/L	0.5	19.4	40.6	0.584
Chloride, Unfiltered Reactive	mg/L	7	11.8	9.2	508.393
Sulphate, Unfiltered Reactive	mg/L	15.4	18.8	16.9	948.396

**Table A6, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0800

Description: 42 inches from A2

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	8300	22200	16400	
COD	mg/L	7	33	16	280.875
Ammonia Plus Ammonium	mg/L	0.08	15.4	2.48	41.331
Total Kjeldahl Nitrogen	mg/L	0.42	17.6	2.98	49.553
Nitrate and Nitrite	mg/L	0.025	5.45	0.64	10.467
DOC	mg/L	0.5	30	3	112.591
TOC	mg/L	3	32	5.8	129.195
Specific Conductance	uS/cm	176	3	263	
Total Suspended Solids	mg/L	0.5	410	10.6	179.549
Aluminum	ug/L	30	350	122	2.05
Strontium	ug/L	92	136	111	1.815
Zinc	ug/L	5	280	42	0.736
Phenolics (4AAP)	ug/L	0.8	31.4	13.8	0.23
Chloride, Unfiltered Reactive	mg/L	8.28	14.2	10.5	171.221
Fluoride, Unfiltered Reactive	mg/L	0.07	0.11	0.087	1.434
Sulphate, Unfiltered Reactive	mg/L	16.8	103	40.7	724.129

**Table A7, ICI Notrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT1100

Description: 72" from A10

Contaminant	Units	Concentration over 12 Month Sampling Period data			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	49100	89100	66800	
DOC	mg/L	0.8	2.7	1.6	103.75
Specific Conductance	uS/cm	195	238	214	
Total Suspended Solids	mg/L	2.2	9	5.7	389.872



**Table A8, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT1200

Description: From Ammonia Storage

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	3680	10700	7880	
DOC	mg/L	0.8	236	1.6	11.899
Specific Conductance	uS/cm	200	236	222	
Total Suspended Solids	mg/L	4.6	12.6	12.7	105.076

For validation data  
see final table

**Table A9, ICI Nitrogen Products, Lambton Works**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN1400

Description: Intake

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	17600	177000	97200	
Nitrate and Nitrite	mg/L	0.33	0.7	0.49	60.797
DOC	mg/L	1.3	2.7	1.98	388.846
Specific Conductance	uS/cm	217	2220	1000	
Total Suspended Solids	mg/L	6	8	7.5	1413.987
Aluminum	ug/L	3	328	99	17.675
Copper	ug/L	2.5	33	18	9.368
Strontium	ug/L		110	96	16.614
Zinc	ug/L	8	99	41	17.498
Phenolics (4AAP)	ug/L	0.8	13.1	4.4	0.014
Chloromethane	ug/L	3.2	12.1	7.2	1.096
Chloride, Unfiltered Reactive	mg/L	6.66	11.8	9.12	2085.631
Sulphate, Unfiltered Reactive	mg/L	16.4	19.4	17.9	3437.756

**Table A10**  
**Toxicity Data for ICI Nitrogen Products for the First Six Months of MISA**  
**Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow Trout	6	non-lethal	6
<u>Daphnia magna</u>	3	>100% to non-lethal	2

CONCENTRATIONS				LOADINGS kg/d							
ATG	PARAMETER	RMDL	UNIT	PR0300	CO 0200	CO 0500	CO 0700	PR0300	CO 0200	CO 0500	CO 0700
c	Total suspended solids	5	mg/L	37	6.56	7.61	5.96	168	1130	80.7	333
c	Hydrogen Ion (pH)			8.78	7.93	8.19	8.24				
c	Specific conductance		uS/cm	516	230	278	212				
c	DOC	0.5	mg/L	10.4	2.72	3.21	3.05	40.5	464	35.3	161
c	TOC	5	mg/L	11.3	4.13	4.71	4.81	43.1	709	48.6	256
c	Oil and grease	1	mg/L	0.687	0.711	0.717	0.766	2.62	120	7.58	43.3
c	Ammonia plus Ammonium	0.25	mg/L	26.1	1.17	2.36	1.39	96.4	200	20.4	63.8
c	Nitrate+Nitrite	0.25	mg/L	24.2	1.13	3.96	0.818	98.3	192	38.8	45.3
c	Total Kjeldahl nitrogen	0.5	mg/L	33	2	3.39	2.92	122	345	29.7	142
c	Total phosphorus	0.1	mg/L	0.36	0.066	0.214	0.123	1.75	11.3	2.11	7.33
09	Aluminum	30	ug/L	413	98	105	89.8	1.82	16	1.11	5.03
09	Boron	50	ug/L	16.8	25	16.9	14.7	0.073	4.36	0.184	0.829
09	Copper	10	ug/L	9.43	2.1	4.55	4.57	0.046	0.349	0.048	0.26
09	Strontium	20	ug/L	133	102	115	98.5	0.585	17.3	1.18	5.59
09	Zinc	10	ug/L	429	5.5	51.9	23.1	1.82	0.966	0.596	1.27
12	Mercury	0.1	ug/L	0.085	0.07	0.11	0.095	—	0.012	0.001	0.005
14	Phenolics (4AAP)	2	ug/L	6.53	7.5	30.9	13.3	0.028	1.402	0.302	0.793
15	Sulphide	20	ug/L	27.5	16.5	15.8	15.8	0.103	2.788	0.182	0.888
16	Chloroform	0.7	ug/L	0.08	0.09	1.61	0.08	—	0.015	0.012	0.005
16	Chloromethane	3.7	ug/L	1.28	5.89	6.63	5.72	0.004	1.105	0.062	0.308
16	Methylene chloride	1.3	ug/L	1.53	7.85	0.221	2.43	0.005	1.200	0.002	0.141
17	m-Xylene and p-Xylene	1.1	ug/L	0.11	0.11	0.11	0.11	—	0.019	0.002	0.006
19	Benzylbutylphthalate	0.6	ug/L	0.165	0.13	0.272	0.418	0.001	0.023	0.004	0.021
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	0.315	0.22	0.465	1.99	0.001	0.038	0.004	0.094
19	Diphenyl ether	0.4	ug/L	0.335	0.22	0.335	0.335	0.001	0.041	0.004	0.018
20	Phenol	2.4	ug/L	1.89	0.37	2.35	10.7	0.009	0.065	0.031	0.584
23	Hexachloroethane	10	mg/L	30.3	5.5	22.8	7.75	—	0.001	0.000	0.001
2	Cyanide Total	0.005	mg/L	0.011	0.007	0.007	0.005	0.042	1.231	0.072	0.316
98	Flow		m3/d	3610	171000	10300	55700				
11	Chloride	2	mg/L	25.7	8.28	12.2	9.2	95.4	1430	137	508
13	Sulphate	5	mg/L	35.2	19.9	21.8	16.9	142	3370	224	948

Continued

ATQ	PARAMETER	CONCENTRATIONS					LOADINGS kg/d			
		RMDL	UNIT	CO 0800	CO 1000	OT 0800	CO 0800	CO 1000	OT 0800	OT 0800
c	Total suspended solids	5	mg/L	7.4	39	5.91	191	2.66		92.5
c	Hydrogen Ion (pH)			7.74	9.16	8.11				
c	Specific conductance		uS/cm	257	7400	218				
c	DOC	5	mg/L	6.94	23.7	1.81	113	1.37		33.7
c	TOC	5	mg/L	7.99	24.6	4.22	129	1.42		69.4
c	Oil and grease	1	mg/L	0.677	0.759	0.653	10.9	0.047		11.9
c	Ammonia plus Ammonium	0.25	mg/L	2.49	0.174	0.112	40.6	0.011		2.04
c	Nitrate+Nitrite	0.25	mg/L	0.652	13	0.364	10.4	0.992		6.69
c	Total Kjeldahl nitrogen	0.5	mg/L	3.01	1.83	0.499	48.9	0.127		9.17
c	Total phosphorus	0.1	mg/L	0.064	0.168	0.047	1.01	0.009		0.859
09	Aluminum	30	ug/L	122	208	79.6	2.05	0.015		1.43
09	Boron	50	ug/L	16	263	16.5	0.272	0.018		0.298
09	Copper	10	ug/L	14.5	20.4	3.53	0.237	0.002		0.067
09	Strontium	20	ug/L	111	1070	98.3	1.82	0.071		1.8
09	Zinc	10	ug/L	42	21.5	22.8	0.735	0.002		0.413
12	Mercury	0.1	ug/L	1.46	0.3		0.021	-		
14	Phenolics (4AAP)	2	ug/L	13.8	2.05	1.24	0.226	-		0.023
15	Sulphide	20	ug/L	16.7	15		0.264	0.001		
16	Chloroform	0.7	ug/L	0.083	0.14		0.001	-		
16	Chloromethane	3.7	ug/L	3.29	2.5		0.048	-		
16	Methylene chloride	1.3	ug/L	0.425	0.2		0.008	-		
17	m-Xylene and p-Xylene	1.1	ug/L	0.111	1.37		0.002	-		
19	Benzylbutylphthalate	0.6	ug/L	0.232	0.7		0.004	-		
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	1.57	3.51		0.023	0.001		
19	Diphenyl ether	0.4	ug/L	0.335	0.45		0.005	-		
20	Phenol	2.4	ug/L	6.94	1.55		0.128	-		
23	Hexachloroethane	10	ng/L	7.75	65		-	-		
2	Cyanide Total	0.005	mg/L	0.006	0.007		0.101	-		
98	Flow	m3/d		16100	58.9	17700				
11	Chloride	2	mg/L	10.5	188		171	11.8		
13	Sulphate	5	mg/L	40.7	3550	17.677	724	205		324

Continued



ATQ	PARAMETER	CONCENTRATIONS					LOADINGS kg/d			
		RMDL	UNIT	OT 1100	OT 1200	IN 1400	OT 1100	OT 1200	IN 1400	
c	Total suspended solids	5	mg/L	5.71	12.7	7.5	390	105		1280
c	Hydrogen Ion (pH)			8.14	8.19	7.58				
c	Specific conductance		uS/cm	215	222	1000				
c	DOC	0.5	mg/L	1.61	1.58	1.98	104	11.9		338
c	Oil and grease	5	mg/L	3.95	3.95	3.78	268	32.3		645
c	Ammonia plus Ammonium	1	mg/L	0.718	0.643	3.71	45.5	5.02		634
c	Nitrate+Nitrite	0.25	mg/L	0.118	0.112	0.207	7.69	0.874		35.4
c	Total Kjeldahl nitrogen	0.25	mg/L			0.487				83.3
c	Total phosphorus	0.1	mg/L			1.63				279
09	Aluminum	30	ug/L	0.052	0.050	0.058	3.49	0.394		9.92
09	Boron	50	ug/L			98.7				16.9
09	Copper	10	ug/L			19.7				3.37
09	Strontium	20	ug/L			17.9				3.05
09	Zinc	10	ug/L			95.6				16.3
12	Mercury	0.1	ug/L			41				7.01
14	Phenolics (HAAP)	2	ug/L			0.36				0.062
15	Sulphide	20	ug/L			4.39				0.75
16	Chloroform	0.7	ug/L			16				2.74
16	Chloromethane	3.7	ug/L			0.08				0.014
16	Methylene chloride	1.3	ug/L			7.17				1.23
17	m-Xylene and p-Xylene	1.1	ug/L			0.317				0.054
19	Benzylbutylphthalate	0.6	ug/L			0.11				0.019
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L			0.3				0.051
19	Diphenyl ether	0.4	ug/L			2.61				0.447
20	Phenol	2.4	ug/L			0.433				0.074
23	Hexachloroethane	10	ng/L			3.03				0.519
2	Cyanide Total	0.005	mg/L			10				0.002
98	Flow		m3/d	66800	7880	0.007				1.2
11	Chloride	2	mg/L			97200				1560
13	Sulphate	5	mg/L			17.9				3060

Continued

ATG	PARAMETER	CONCENTRATIONS						LOADINGS kg/d			
		RMDL	UNIT	CO 0800	CO 1000	OT 0600		CO 0800	CO 1000	OT 0600	
c	Total suspended solids	5	mg/L	11.4	39	5.91		191	2.66	92.5	
c	Hydrogen Ion (pH)			7.74	9.16	8.11					
c	Specific conductance		uS/cm	257	7400	218					
c	DOC	0.5	mg/L	6.94	23.7	1.81		113	1.37	33.7	
c	TOC	5	mg/L	7.99	24.6	4.22		129	1.42	69.4	
c	Oil and grease	1	mg/L	0.677	0.759	0.653		10.9	0.047	11.9	
c	Ammonia plus Ammonium	0.25	mg/L	2.49	0.174	0.112		40.6	0.011	2.04	
c	Nitrate + Nitrite	0.25	mg/L	0.652	13	0.364		10.4	0.992	6.69	
c	Total Kjeldahl nitrogen	0.5	mg/L	3.01	1.83	0.499		48.9	0.127	9.17	
c	Total phosphorus	0.1	mg/L	0.064	0.168	0.047		1.01	0.009	0.859	
09	Aluminum	30	ug/L	122	208	79.6		2.05	0.015	1.43	
09	Boron	50	ug/L	16	263	16.5		0.272	0.018	0.298	
09	Copper	10	ug/L	14.5	20.4	3.53		0.237	0.002	0.067	
09	Strontium	20	ug/L	111	1070	98.3		1.82	0.071	1.8	
09	Zinc	10	ug/L	42	21.5	22.8		0.735	0.002	0.413	
12	Mercury	0.1	ug/L	1.46	0.3	0.021		0.021	—	—	
14	Phenolics (4AAP)	2	ug/L	13.8	2.05	1.24		0.226	—	—	
15	Sulphide	20	ug/L	16.7	15			0.264	0.001	0.023	
16	Chloroform	0.7	ug/L	0.083	0.14			0.001	—	—	
16	Chloromethane	3.7	ug/L	3.29	2.5			0.048	—	—	
16	Methylene chloride	1.3	ug/L	0.425	0.2			0.008	—	—	
17	m-Xylene and p-Xylene	1.1	ug/L	0.111	1.37			0.002	—	—	
19	Benzylbutylphthalate	0.6	ug/L	0.232	0.7			0.004	—	—	
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	1.57	3.51	0.023		0.023	0.001		
19	Diphenyl ether	0.4	ug/L	0.335	0.45			0.005	—	—	
20	Phend	2.4	ug/L	6.94	1.95			0.128	—	—	
23	Hexachloroethane	10	ng/L	7.75	65			—	—	—	
2	Cyanide Total	0.005	mg/L	0.006	0.007			0.101	—	—	
98	Flow		m3/d	16100	58.9	17700					
11	Chloride	2	mg/L	10.5	188			171	11.9		
13	Sulphate	5	mg/L	40.7	3550	17 677		724	205	324	

Continued

ATG	PARAMETER	CONCENTRATIONS					LOADINGS kg/d			
		RMDL	UNIT	OT 1100	OT 1200	IN 1400	OT 1100	OT 1200	IN 1400	
c	Total suspended solids	5	mg/L	5.71	12.7	7.5	390	105	1280	
c	Hydrogen ion (pH)			8.14	8.19	7.58				
c	Specific conductance		uS/cm	215	222	1000				
c	DOC	0.5	mg/L	1.61	1.58	1.98				
c	TOC	5	mg/L	3.95	3.95	3.78	104	11.9	338	
c	Oil and grease	1	mg/L	0.718	0.643	3.71	268	32.3	645	
c	Ammonia plus Ammonium	0.25	mg/L	0.118	0.112	0.207	45.5	5.02	634	
c	Nitrate + Nitrite	0.25	mg/L			0.487	7.69	0.874	35.4	
c	Total Kjeldahl nitrogen	0.5	mg/L			1.63			83.3	
c	Total phosphorus	0.1	mg/L	0.052	0.050	0.058	3.49	0.394	279	
09	Aluminum	30	ug/L			98.7			9.92	
09	Boron	50	ug/L			19.7			16.9	
09	Copper	10	ug/L			17.9			3.37	
09	Strontium	20	ug/L			95.6			3.05	
09	Zinc	10	ug/L			41			16.3	
12	Mercury	0.1	ug/L			0.36			7.01	
14	Phenolics (4AAP)	2	ug/L			4.39			0.062	
15	Sulphide	20	ug/L			16			0.75	
16	Chloroform	0.7	ug/L			0.08			2.74	
16	Chloromethane	3.7	ug/L			7.17			0.014	
17	m-Xylene chloride	1.3	ug/L			0.317			1.23	
19	m-Xylene and p-Xylene	1.1	ug/L			0.11			0.054	
19	Benzylbutylphthalate	0.6	ug/L			0.3			0.019	
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L			2.61			0.051	
19	Diphenyl ether	0.4	ug/L			0.433			0.447	
20	Phenol	2.4	ug/L			3.03			0.074	
23	Hexachloroethane	10	ng/L			10			0.519	
2	Cyanide Total	0.005	mg/L			0.007			0.002	
98	Flow		m3/d	68800	7880	97200			1.2	
11	Chloride	2	mg/L			9.12			1560	
13	Sulphate	5	mg/L			17.9			3060	

Continued

Notes:

Streams listed for monitoring under regulation at this plant were:

PR0300 is the effluent stream "Drainage Ditch after Emergency Containment Basin" which flows into 0200.  
CO0200 is the "Plant Final Effluent" which discharges into the St. Clair River.  
CO0400 is the stream "Effluent from Gypsum Ponds". No data were reported for this stream.  
CO0500 is the stream "Effluent from 30" Concrete Pipe" which discharges into 0200.  
CO0700 is the stream "Effluent in Manhole #55" which discharges into 0200.  
CO0800 is the stream "Effluent in 42" from A-1I" which discharges into 0200.  
CO1000 is the effluent stream "A-1I Neutralizer Pit Overflow" also discharging into 0200. Monitoring ceased May 1990.  
BA0900 is the stream "Effluent from A-1 Regenerator". No usable data were reported before shutdown March 1990.  
OT0600 is the stream "Effluent in 18" Black Polyethylene Pipe" which discharges into 0200.  
OT1100 is the stream "Effluent in 72" line from A-1I" which discharged into 0200.  
OT1200 is the stream "Effluent in Open Ditch from Ammonia Storage" which discharges into 0200.

Flow measurements at 0300, 0200, 0500 and 0800 used primary devices with externally established performance.

All were hydraulically modified but may be reliable within the regulation accuracy requirements.

Flow values and loadings for other streams should be interpreted with caution.

Methods of unestablished accuracy levels were used for flow values at these points.

Intake loadings are based on CO0200 mean flow and are probable upper bound values;  
this is because of rain contributions to the flow from the large plant catchment area.

## **APPENDIX 13**

**International Minerals and Chemical Corporation (Canada) Ltd.**





**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
INTERNATIONAL MINERALS AND CHEMICAL  
CORPORATION (CANADA) LTD.**

**1.0            PLANT DESCRIPTION**

International Minerals and Chemicals (IMC) shutdown its manufacturing units in 1984. The plant had manufactured phosphoric acid, sulphuric acid, calcium phosphate, mono ammonium phosphate, and various grades of super-phosphate fertilizer. The operation of the wastewater treatment facility, and the management of the decommissioning operations constitute the primary activities at IMC. IMC's wastewater treatment facility is used to treat storm water from onsite phosphogypsum ponds and the plant site.

The intake water, from the Grand River, is screened and chlorinated by the Town of Dunnville. Water is used to make slaked lime slurry for treating storm water, for domestic purposes and for dust control of the uncapped portion of one of the phosphogypsum ponds.

Details on the plant, the water treatment facility and wastewater generation are presented in the site visit report (Ref. 1).

**2.0            WASTEWATER SOURCES AND QUALITY**

**2.1            Sources**

All wastewater generated on the site is collected in the Pretreatment Collection Pond, and passes through the wastewater treatment plant prior to discharge to the Grand River. The wastewater stream consists of:

- Runoff and seepage into ditches around the phosphogypsum Ponds A, B and C.
- Storm water runoff from the plant site.
- Wastewater from Pond D2, which includes wastewater treatment plant sludge supernatant, overflows from the Pretreatment Collection Pond and runoff and seepage collected in ditches around Ponds D1 and D2.

The net rate of wastewater generation from these sources is equivalent to the net annual precipitation on the total plant property (i.e. precipitation minus evaporation), plus any additional raw water that was added to flood the surface of Pond A for dust

control. During the 12 month MISA Monitoring Regulation period, this flow averaged 2,820 m<sup>3</sup>/d.

At the wastewater treatment facility, a slaked lime slurry is added to the wastewater for phosphorus and fluoride removal in two mixed reactors connected in series. The effluent from the second reactor discharges to the primary settling tank, where a polymeric flocculant is added (Alchem Inc. 85030). Ferrous chloride is added to the effluent from the primary settling tank to further improve phosphorus and fluoride removal. The effluent from the secondary settling tank is discharged to an outdoor settling pond (polishing pond), which discharges to the Grand River at Control Point CO0300.

## 2.2 Wastewater Flows and Quality

Appendix Table A1 Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0300 at International Minerals and Chemical Corporation (Canada) Ltd.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed in the following discussion.

### **BAT Option 1**

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Appendix Table A2. Seven rainbow trout tests and six Daphnia magna tests were carried out on samples taken at Control Point CO0300. The lethal concentrations of the trout samples ranged from 86.4 percent to non-lethal, with three non-lethal samples. Half of the samples tested with Daphnia magna were non-lethal and the remainder had lethal concentrations greater than 100 percent. Since a review of the "Priority 1" pollutants presented in Table A1 reveals no obvious toxicity source, IMC should consider implementing a Toxicity Reduction Study.

In order to produce a non-toxic effluent, several tasks should be considered within the scope of a Toxicity Reduction Study, including:

- Confirm the toxicity of the effluent.
- Enumerate potential toxic contaminants.
- Identify sources of potential toxic contaminants.
- Identify alternatives to eliminate toxic contaminants.
- Develop a toxicity reduction management program.
- Implement a toxicity reduction management program.

Since BAT Option 1 is dependent upon the outcome of the Toxicity Reduction Study, no recommendations concerning the application of pollution control technology can be made at this time.

### **BAT Option 2**

Under 40 CFR Part 418 of the U.S. Federal Register (July 1, 1989 Edition), Subpart A, BAT is defined for the phosphate subcategory. Since IMC is discharging process wastewater pollutants from the phosphogypsum ponds only, a portion of the U.S. BAT for this Subcategory do not apply. The relevant regulations include:

1. The wastewater treatment facility must be designed, constructed and operated to maintain a surge capacity equal to the runoff from the 25 year 24 hour rainfall event.
2. The effluent must be in compliance with the maximum daily limit, and the average over 30 days, for total phosphorus, and fluoride. The U.S. EPA BAT effluent limits, compared with the effluent levels achieved at IMC during the MISA Monitoring Regulation period are presented in Table 1.

The total suspended solids limits (150 mg/L daily maximum, and 50 mg/L maximum average over 30 days) are waived from runoff from a calcium sulphate storage pile by the U.S. EPA, provided the wastewater is chemically treated, and settled or clarified to meet the other pollutant limitations.

<p align="center"><b>Table 1</b> <b>U.S. BAT Limits Compared to IMC Effluent Concentrations<sup>1</sup></b></p>				
Parameter	U.S. BAT Effluent Limit (mg/L)		IMC Effluent Concentrations (mg/L)	
	Daily Maximum (mg/L)	Average Over 30 Days (mg/L)	Daily Maximum (mg/L)	Average Over 30 Days (mg/L)
Total Phosphorus	< 105	< 35	1.73	0.41 to 0.77
Fluoride	< 75	< 25	16.8	6.8 to 12.6
Total Suspended Solids	< 150	< 50	7.71	5.25 to 12.5
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. Data from 12 month MISA Monitoring Regulation period.</li> <li>2. Range of monthly averages from 12 month MISA Monitoring Regulation period.</li> <li>3. U.S. BAT suspended solids limits are waived for effluent from gypsum storage piles.</li> </ol>				

The first U.S. BAT regulation is satisfied, since the freeboard storage capacity in the two onsite storage ponds amounts to 370,000 m<sup>3</sup> compared to a volume of 107,240 m<sup>3</sup>, which corresponds to a 25-year 24-hour rainfall event (Ref. 4 and 5).

The data presented in Table 1 reveals that IMC is already achieving an effluent quality well above the U.S. BAT. Therefore, no changes to the existing system at IMC are recommended under BAT Option 2.

### **BAT Option 3**

Although there were two Ontario phosphorus plants included in this study, they are significantly different.



Albright and Wilson Americas produces phosphoric acid using the dry furnace process, as well as secondary products such as sodium and potassium phosphates, whereas the only activity at IMC is the treatment of storm water from the phosphogypsum ponds and the plant site, and the management of the decommissioning activities.

ICI Courtright (Lambton Works) also produced phosphate-based fertilizers until shut-down of those units in 1984. From October 1985 to October 1987, process wastewater from the ICI phosphogypsum ponds was treated using a lime addition and settling system followed by direct discharge. However, this practice was stopped by the MOE in 1987. Currently, process wastewater remaining in the ponds is being held until final decisions regarding treatment and discharge are made.

Since IMC is demonstrating the best technology currently in use in the Ontario Inorganic Chemical Sector, the recommended BAT Option 3 is the existing system.

#### **BAT Option 4**

BAT Option 4 is intended to provide maximum overall water pollution control. Examination of the "Priority 1" pollutants found in CO0300 during the MISA Monitoring Regulation period suggests that only a few of the contaminants present are at treatable levels.

Although the level of oil and grease is low (1.06 mg/L), an oil absorption column presented in the General Technology Report (Ref. 2) could be used to reduce these levels. The likely source of oil and grease is storm water from the plant areas. Reduction or elimination of this contaminant will likely be based on in-plant management practices, or storm water control.

Coagulation, settling and filtration could be used to reduce the total suspended solids concentration from 7.7 mg/L to 5 mg/L (Ref. 3). However, implementation of coagulation/settling/filtration system will produce related problems which must be addressed, including:

- The impacts of water treatment chemicals on effluent, in terms of contaminant concentrations and toxicity.
- The handling and disposal of wastewater treatment residuals.
- The dependence of removal performance on system reliability and operator training.

Because of these problems and the very low levels of TSS in the effluent, technologies to reduce TSS are not recommended in BAT Option 4.

In order to reduce or remove sulphide (40 µg/L) from the effluent, oxidation to a sulphur-floc and/or sulphate is recommended. Due to the non-selective nature of oxidizing agents, and the presence of other oxidizable species in the wastewater, it is difficult to predict the optimum pH, the required time for reaction completion, the oxidizing agent dosage, and the most effective oxidizing agent, without significant bench testing (Ref. 6). Because the sulphide levels in the effluent are not excessive, and the proposed treatment is not likely to effect a significant change in the effluent quality, BAT Option 4 does not include a recommendation for sulphide removal.

Both fluoride (9.42 mg/L) and sulphate (1,690 mg/L) likely originate from the phosphogypsum ponds. Because sulphate and fluoride are highly soluble, conventional means of removal (i.e. chemical addition) are not feasible.

Both the fluoride and sulphate are present at treatable levels. The treatment technology that would be required includes:

- Preconcentration of the waste stream using reverse osmosis, ion exchange or electrodialysis. Flow rates of residuals requiring further treatment will total approximately 10 to 30 percent of the original flow.
- Further concentration of the waste stream through evaporative technologies such as vapour compression evaporation or steam-driven evaporation.
- Crystallization of the concentration waste stream through the use of spray dryers or equivalent technologies.
- Disposal of resulting solid wastes.

Preconcentration technologies require careful control of operating conditions to avoid fouling or deterioration of membranes or resins and may require additional pretreatment steps such as removal of solids and/or organics. All of these technologies are both energy and labour intensive. Further description of these technologies, and more detailed information on capital and operating costs appear in a separate report. These added operational and technological complexities are not likely to be offset by the improvements in wastewater quality which would result at IMC. Thus, BAT Option 4 does not include measure for the control of dissolved solids such as fluorides and sulphates.

Technologies for the removal of low levels of the remaining contaminants which are primarily metals, present in the effluent at Control Point CO0300, may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluent

with similar contaminant concentrations. Thus, recommendations for BAT Option 4 do not include technologies for the removal of these contaminants.

Careful review of the process, raw materials, product and chemicals used at the plant within the scope of this study did not reveal a source of phenol (8.8 µg/L). The likely source of phenols is storm water from the plant area. Reduction or elimination of this contaminant will be likely based on best management practices, or storm water control.

In summary, no changes to the existing system at IMC are recommended under BAT Option 4.

### **BAT Option 5**

Opportunities for consumption of the treated effluent from IMCs wastewater treatment facility do not exist, nor is construction of an evaporation pond with sufficient capacity to evaporate the current discharges feasible. The recommendation for BAT Option 5 is the existing system.

### **Summary**

A summary of the BAT Options for IMC are presented in Table 2.

<b>Table 2</b> <b>Summary of BAT Options for International Minerals and Chemical Corporation</b> <b>(Canada) Ltd.</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluent.	Dependant upon outcome of Toxicity Reduction Study.
2	U.S. BAT.	No change to existing system.
3	Best demonstrated in Ontario.	No change to existing system.
4	Maximum reduction of pollutants.	No change to existing system.
5	Furthest towards zero-discharge of pollutants.	No change to existing system.

1. Inorganic Chemical Manufacturing Sector Plants, Site Visit Report, International Minerals and Chemical Corporation (Canada) Ltd. March 21, 1991 (unpublished).
2. General Technology Report, Oil and Grease Removal by Absorption.
3. Sister Plant Technology Report, Coagulation/Settling/Filtration Ponds at Cabot Canada Ltd.
4. Atmospheric Environment Service, IDF 87 program.
5. Telephone conversation with Jim Irwin of International Minerals Corporation (Canada) Ltd. November 1991.
6. Nalco Chemical Company, *The Nalco Water Handbook*. Toronto, McGraw- Hill Book Company, 1979.

## **APPENDIX**

### **Tables**





**Table A1, International Minerals and Chemicals Corporation  
(Canada) Ltd., Port Maitland**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0300

Description: Final Effluent

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	336	3870	2820	
COD	mg/L	39	40	39.5	108.234
Hydrogen Ion (pH)		6.5	9.35	7.632	
Ammonia Plus Ammonium	mg/L	0.025	8.2	1.088	3.069
Total Kjeldahl Nitrogen	mg/L	0.16	9	1.647	4.708
Nitrate and Nitrite	mg/L	0.025	2.7	0.757	2.126
DOC	mg/L	5	13	7.6	20.51
TOC	mg/L	5.6	7.3	6.912	18.576
Total Phosphorus	mg/L	0.14	0.73	0.654	1.866
Specific Conductance	uS/cm	1540	2780		
Total Suspended Solids	mg/L		19	7.7	21.798
Aluminum	ug/L	9	550	69	0.203
Boron	ug/L	58	110	87.5	0.237
Strontium	ug/L	500	1200	822	2.254
Zinc	ug/L	4	43	10.2	0.03
Phenolics (4AAP)	ug/L	3	50	8.8	0.021
Sulphide	ug/L	20	60	40	0.106
Oil and Grease	mg/L	0.96	2.2	1.06	3.048
Chloride, Unfiltered Reactive	mg/L	40	44	42	114.808
Fluoride, Unfiltered Reactive	mg/L	5.3	16.8	9.42	26.544
Sulphate, Unfiltered Reactive	mg/L	700	2500	1690	4826.212

**Table A2**  
**Toxicity Data for International Minerals and Chemical Corporation (Canada) Ltd.**  
**for the First Six Months of MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Data	Number of Non-Lethal Samples
Rainbow trout	7	86.5% to non-lethal	3
<u>Daphnia magna</u>	6	> 100% to non-lethal	3

# IMC

## Port Maitland

		CONCENTRATIONS		LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	CO 0300	CO 0300
c	Total suspended solids	5	mg/L	7.76	22.3
c	Hydrogen ion (pH)			7.68	
c	Specific conductance		uS/cm	2860	
c	DOC	0.5	mg/L	7.6	20.5
c	TOC	5	mg/L	6.91	18.6
c	Oil and grease	1	mg/L	1.06	3.05
c	Ammonia plus Ammonium	0.25	mg/L	1.09	3.07
c	Nitrate + Nitrite	0.25	mg/L	0.757	2.13
c	Total Kjeldahl nitrogen	0.5	mg/L	1.65	4.71
c	Total phosphorus	0.1	mg/L	0.645	1.87
09	Aluminum	30	ug/L	69	0.203
09	Boron	50	ug/L	87.5	0.237
09	Strontium	20	ug/L	823	2.25
09	Zinc	10	ug/L	10.2	0.03
14	Phenolics (4AAP)	2	ug/L	8.75	0.021
15	Sulphide	20	ug/L	40	0.106
24	Octachlorodibenzo-p-dioxin	30	pg/L	41	—
98	Ftflow		m3/d	2860	
I1	Chloride	2	mg/L	42	115
I2	Fluoride	0.1	mg/L	9.48	27.1
I3	Sulphate	5	mg/L	1690	4830

### Notes

CO0300 is the stream "Final Effluent to River". This discharges into Lake Erie.





## **APPENDIX 14**

### **Liquid Carbonic (Courtright)**



# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### LIQUID CARBONIC INC. (COURTRIGHT)

#### 1.0 PLANT DESCRIPTION

Liquid Carbonic Inc. in Courtright, Ontario, produces purified liquid carbon dioxide in a two-stage compression and cooling process. Intake water from the St. Clair River is used at the plant for once through non-contact cooling of compression and condensing systems. Details on the plant, processes and wastewater generation are provided in the associated site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

Discharge sources from the plant include once through non-contact cooling water, roof stormwater, and compressor condensate and wash water from within the process building, which have been treated in an oil water separator. These were all combined for monitoring under the MISA Monitoring Regulation at Control Point CO0100. The average flow at this point during the 12 months of MISA monitoring was 4,849 m<sup>3</sup>/d.

#### 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at Liquid Carbonic (Courtright).

Table A2 presents contaminants measured in intake water, at IN0200.

### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for wastewater management, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of the Options are addressed in the following discussion.

#### BAT Option 1

Toxicity data were collected and verified for the first six months of the MISA Regulation Monitoring period by the Ministry of the Environment. Three tests of the final effluent at Control Point CO0100 were carried out on rainbow trout and Daphnia magna. All of the samples were non-lethal. Thus, the existing wastewater management system is considered BAT Option 1.

#### BAT Option 2

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition), Subpart AF for the Carbon Dioxide Production Subcategory, effluent limitations were not

---

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control study at each site.

defined and the category was reserved. Therefore, a BAT Option 2, incorporating technologies selected by the U.S. EPA for comparable facilities, was not identified.

### **BAT Option 3**

Five Ontario gas plants included in the Ontario Inorganic Chemical Sector were examined as part of this study. A summary of wastewater technology at Ontario gas plants is presented in Table 1. Both cooling towers and once through cooling water systems are used, in addition to gravity oil/water separation of compressor condensates.

<p align="center"><b>Table 1</b> <b>Comparison of Operating Features at Five Ontario Gas Plants</b></p>	
<b>Plant</b>	<b>Operating Feature</b>
Linde (Division of Union Carbide Canada Ltd.) - Moore Township	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sarnia	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Bird-Archer 3057</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sault Ste. Marie	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 546</li> <li>- Dearborn 726</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Dearborn 747</li> </ul> </li> <li>• Cooling tower blowdown solids are concentrated in a cyclone separator prior to discharge.</li> <li>• Water source- Lake Superior.</li> </ul>
Liquid Carbonic Inc. - Courtright	<ul style="list-style-type: none"> <li>• Once through non-contact cooling water.</li> <li>• Water source- ICI Nitrogen Products, Lambton Works</li> </ul>
Liquid Carbonic Inc. - Maitland	<ul style="list-style-type: none"> <li>• Both once through and cooling tower non-contact cooling water is used.</li> <li>• Water treatment chemicals:               <ul style="list-style-type: none"> <li>- Betz C63P (bromine)</li> <li>- Betz MS-120</li> <li>- Betz J-12</li> <li>- Betz 35106</li> <li>- Betz K-1-2</li> </ul> </li> <li>• Water source- onsite well.</li> </ul>



Although systems vary slightly from plant to plant, in general, all of these plants have equivalent technologies for wastewater management, and no one plant could be considered as representing the best in use in Province. Thus, BAT Option 3 was defined as the existing system at the Liquid Carbonic, Courtright plant.

#### **BAT Option 4**

Review of the raw water and effluent data shows that none of the contaminants in effluents from the plants were at levels that significantly exceeded those in raw water. Thus, there is no indication that contaminants are being contributed through plant operations.

Technologies for the removal of low levels of contaminants present in Liquid Carbonic effluents may be available and have been used in specific non-specific applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 is defined as the existing system.

#### **BAT Option 5**

Technologies that would advance the plant toward zero-discharge of contaminants were not identified in a global search. Cooling water provided by once through or recirculating cooling tower systems is invariably used to cool process equipment in industrial gas manufacturing. Other cooling methods, such as closed loop air cooled systems, would require very large capital expenditures and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario.

And finally, opportunities for consumption of cooling water, condensate or wash water do not exist in the compression and purification of carbon dioxide gas. Therefore, BAT Option 5 was defined as the existing system.

#### **Summary**

Table 2 presents a summary of BAT Options identified for the Liquid Carbonic, Courtright plant.

**Table 2**  
**Summary of BAT Options for Liquid Carbonic, Courtright**

BAT Option	Definition	Description
1	Least cost producing non-lethal effluents.	No changes to existing system.
2	U.S. BAT.	No U.S. BAT defined.
3	Best demonstrated in Ontario.	No changes to existing system.
4	Maximum reduction of pollutants.	No changes to existing system.
5	Furthest toward zero-discharge contaminants.	No changes to existing system.

#### 4.0

#### REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report - Liquid Carbonic Inc.; (Courtright) March 29, 1991 (unpublished).



## **APPENDIX**

### **Tables**





**Table A1, Liquid Carbonic Inc., Courtright**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: South Ditch

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	297	1360	4850	
Hydrogen Ion (pH)		7.1	11	8.5	
DOC	mg/L	0.5	45	5.8	29.053
TOC	mg/L	0.5	45	5.9	30.852
Specific Conductance	uS/cm	25	180	217	
Aluminum	ug/L	25	122	64	0.32
Boron	ug/L	13	225	72.1	0.406
Strontium	ug/L	23	2170	415	2.579
Zinc	ug/L	3	59	14	0.076
Oil and Grease	mg/L	0.6	10.8	2.5	11.5

**Table A2, Liquid Carbonic Inc., Courtright**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN0300

Description: Intake

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
DOC	mg/L	0.5	1.0	2
Aluminum	ug/L	25	99	52
Boron	ug/L	108	215	84
Strontium	ug/L	3	2500	590
Zinc	ug/L	0.8	376	87
Oil and Grease	mg/L	12.8		5

**Table A3**  
**Toxicity Data for Liquid Carbonic Inc. (Courtright) for the First Six Months of**  
**MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non- lethal Samples
Rainbow trout	3	all non-lethal	3
<u>Daphnia magna</u>	3	all non-lethal	3

# Liquid Carbonic Courtright

ATG	PARAMETER	CONCENTRATIONS				LOADINGS kg/d	
		RMDL	UNIT	CO 0100	IN 0300	CO 0100	IN 0300
c	Total suspended solids	5	mg/L	2.93	3.33	14.1	16.1
c	Hydrogen ion (pH)			8.47			
c	Specific conductance		uS/cm	217			
c	DOC	0.5	mg/L	5.79	2.5	29.1	12.1
c	TOC	5	mg/L	5.89	3.7	30.9	18
c	Oil and grease	1	mg/L	2.52	4.97	11.5	24.1
c	Ammonia plus Ammonium	0.25	mg/L	0.31		0.433	
c	Nitrate+Nitrite	0.25	mg/L	0.2		0.279	
c	Total Kjeldahl nitrogen	0.5	mg/L	0.5		0.698	
c	Total phosphorus	0.1	mg/L	0.019	0.01	0.101	0.049
09	Aluminum	30	ug/L	63.5	51.6	0.32	0.25
09	Boron	50	ug/L	72.1	83.8	0.406	0.407
09	Strontium	20	ug/L	415	590	2.58	2.86
09	Zinc	10	ug/L	14.5	87	0.076	0.422
98	Ftflow		m3/d	4860			

## Notes

CO0100 is the "Effluent to South Ditch".

Discharge is to the St. Clair River via ICI Courtright stream CO 0200.

## **APPENDIX 15**

### **Liquid Carbonic (Maitland)**





# INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### LIQUID CARBONIC INC. (MAITLAND)

#### 1.0 PLANT DESCRIPTION

Liquid Carbonic in Maitland, Ontario, purifies and compresses carbon dioxide in four independent production plants, in addition to producing of dry ice. Water supplied to the plant from an on-site well is used as once through cooling water, gas scrubber water and wash water. A portion of water is softened for use as cooling tower make-up water. Details on the plant processes and wastewater management are presented in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Sources

All discharges within the plant were combined for monitoring at a single MISA Control Point CO0100 during the MISA Regulation monitoring period. Discharges sources include:

- Compressor condensate from all four production units, and floor drain discharges from two units which have been treated in a single gravity oil/water separator.
- Once through cooling water from one production unit and from the dry ice plant.
- Gas scrubber water from one production unit, which is produced intermittently.
- Cooling tower blowdown from a cooling system that is used in three production units.
- Water softener backwash water.
- Storm water runoff from all plant areas including roof drains.

Flow data were not provided for the proportion of flow contributed from each source.

## 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents the mean, minimum and maximum flow and concentration data from MISA Control Point CO0100 for the parameters defined by the Ontario Ministry of the Environment as Priority 1.

Table A2 presents data from the 12 months monitoring period for the intake wear measured at IN0300.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for wastewater management, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

### **BAT Option 1**

Toxicity data were collected and verified for the first six months of the MISA Regulation Monitoring period by the Ministry of the Environment. Three tests of the final effluent at Control Point CO0100 were carried out on rainbow trout and Daphnia magna. All of the samples were non-lethal. Thus, the existing wastewater management system is considered BAT Option 1.

### **BAT Option 2**

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition), subpart AF for the Carbon Dioxide Production Subcategory, effluent limitations were not defined and the category was reserved. Therefore, a BAT Option 2, incorporating technologies selected by the U.S. EPA for comparable facilities, was not identified.

### **BAT Option 3**

Five Ontario gas plants included in the Ontario Inorganic Chemical Sector were examined as part of this study. A summary of wastewater technology at Ontario gas plants is presented in Table 1. Both cooling towers and once through cooling water systems are used, in addition to gravity oil/water separation of compressor condensates. Although systems vary slightly, from plant to plant, in general, all of these plants have equivalent technologies for wastewater management, and no one plant could be considered as representing the best in use in Province. Thus, BAT Option 3 was defined as the existing system at the Liquid Carbonic, Maitland plant.

### **BAT Option 4**

Review of the raw water and effluent data shows that none of the contaminants in effluents from the plants were at levels that significantly exceeded those in raw water. Thus, there is no indication that contaminants are being contributed through plant operations.

Technologies for the removal of low levels of contaminants present in Liquid Carbonic effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 is defined as the existing system.

<p align="center"><b>Table 1</b> <b>Comparison of Operating Features at Five Ontario Gas Plants</b></p>	
<b>Plant</b>	<b>Operating Feature</b>
Linde (Division of Union Carbide Canada Ltd.) - Moore Township	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sarnia	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Bird-Archer 3057</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sault Ste. Marie	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 546</li> <li>- Dearborn 726</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Dearborn 747</li> </ul> </li> <li>• Cooling tower blowdown solids are concentrated in a cyclone separator prior to discharge.</li> <li>• Water source- Lake Superior.</li> </ul>
Liquid Carbonic Inc. - Courtright	<ul style="list-style-type: none"> <li>• Once through non-contact cooling water.</li> <li>• Water source- ICI Nitrogen Products, Lambton Works</li> </ul>
Liquid Carbonic Inc. - Maitland	<ul style="list-style-type: none"> <li>• Both once through and cooling tower non-contact cooling water is used.</li> <li>• Water treatment chemicals:               <ul style="list-style-type: none"> <li>- Betz C63P (bromine)</li> <li>- Betz MS-120</li> <li>- Betz J-12</li> <li>- Betz 35106</li> <li>- Betz K-1-2</li> </ul> </li> <li>• Water source- onsite well.</li> </ul>

### **BAT Option 5**

Technologies that would advance the plant further toward zero-discharge of contaminants were not identified in a global search. Cooling water provided by once through or recirculating cooling tower systems is invariably used to cool process equipment in industrial gas manufacturing. Other cooling methods, such as closed loop air systems, would require very large capital expenditures and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Thus, this approach to cooling is not used in the industry.



And finally, opportunities for consumption of cooling water, condensate or wash water do not exist in the compression and purification of carbon dioxide gas. Therefore, technologies included in BAT Option 5 are the only existing system, since those that further the plant more toward zero discharge were not identified.

### Summary

Table 2 presents a summary of BAT Options identified for the Liquid Carbonic, Maitland plant.

Table 2 Summary of BAT Options for Liquid Carbonic, Maitland		
BAT Option	Definition	Description
1	Least cost producing non-lethal effluents.	No changes to existing system.
2	U.S. BAT.	No U.S. BAT defined.
3	Best demonstrated in Ontario.	No changes to existing system.
4	Maximum reduction of pollutants.	No changes to existing system.
5	Furthest toward zero-discharge of pollutants.	No changes to existing system.

## 4.0

### REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report - Liquid Carbonic Inc.; (Maitland). April 25, 1991 (unpublished).



## **APPENDIX**

### **Tables**



**Table A1, Liquid Carbonic Inc., Maitland**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: Main

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0.454	2960	2180	
DOC	mg/L	0.5	51	8.02	18.032
TOC	mg/L	0.5	51	9.25	18.547
Specific Conductance	uS/cm	76	240	848	
Aluminum	ug/L	25	487	87.8	0.083
Boron	ug/L	16	280	195	0.458
Strontium	ug/L	100	2580	1640	3.909
Zinc	ug/L	3	448	86.7	0.214
Oil and Grease	mg/L	0.1	12.2	2.8	5.949



**Table A2, Liquid Carbonic Inc., Maitland**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN0300

Description: Intake

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
TOC	mg/L	25	135	5.5
Aluminum	ug/L	25	302	62
Boron	ug/L	122	2140	188
Strontium	ug/L	49	664	244
Zinc	ug/L	0.5	14	5.2
Oil and Grease	mg/L			

**Table A3**  
**Toxicity Data for Liquid Carbonic Inc. (Maitland) for the First Six Months of**  
**MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow trout	4	all non-lethal	4
<u>Daphnia magna</u>	3	>100 % to non-lethal	2

**Liquid Carbonic Inc.**  
**Maitland**

		CONCENTRATIONS				LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	CO 0100	IN 0300	CO 0100	IN 0300
c	Total suspended solids	5	mg/L	1.32	1.1	2.86	2.4
c	Hydrogen ion (pH)			7.71			
c	Specific conductance		uS/cm	848			
c	DOC	0.5	mg/L	8.02	1.9	18	4.15
c	TOC	5	mg/L	9.25	5.46	18.5	11.9
c	Oil and grease	1	mg/L	2.88	5.22	5.95	11.4
c	Ammonia plus Ammonium	0.25	mg/L	0.35		0.807	
c	Nitrate+ Nitrite	0.25	mg/L	3.9		8.99	
c	Total Kjeldahl nitrogen	0.5	mg/L	0.6		1.38	
c	Total phosphorus	0.1	mg/L	0.064	0.127	0.162	0.277
09	Aluminum	30	ug/L	87.8	61.6	0.084	0.134
09	Boron	50	ug/L	195	188	0.458	0.411
09	Strontium	20	ug/L	1640	1660	3.91	3.63
09	Zinc	10	ug/L	86.7	244	0.214	0.533
98	Ftflow		m3/d	2180			

**Notes**

Flow data accuracy may have been affected by a hydraulic disturbance immediately upstream of the primary flow monitoring device.

CO0100 is the "Effluent to Main Outfall" which flows to the St. Lawrence River.

## **APPENDIX 16**

**Nitrochem Inc.**



# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### NITROCHEM INC.

#### 1.0 PLANT DESCRIPTION

Nitrochem Inc. in Maitland produces anhydrous ammonia, nitric acid, ammonium nitrate liquor, ammonium nitrate prills and "nitrogen solutions" (primarily urea ammonium nitrate). Intake water from the St. Lawrence River is filtered and chlorinated for use at the plant. A portion of water is further treated by carbon adsorption and softening for use as boiler water make-up. Additional treatment by ion exchange and carbon dioxide degassing is employed for water used in the hydrogen plant and in nitrogen solutions production.

Details on the plant processes, water use and wastewater sources are provided in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Wastewater Sources

With a few exceptions, all process wastewater streams generated at Nitrochem are collected and reused in the production of liquid nitrogen fertilizer products. One concentrated ammonia contaminated stream, and several minor streams such as air compressor condensates, decarbonation solution and gas scrubber water are directed to a Clear Water Pond, which discharges to the St. Lawrence River. Non-process effluents, including boiler and cooling tower blowdown, water treatment regenerants and backwash water are also directed to this pond.

An anaerobic digestion system is used to treat sanitary flows generated at the plant. Chlorinated supernate from the digester combines with the Clear Water Pond effluent for discharge.

The most contaminated storm water runoff from the production area produced at the beginning of a rainfall event, referred to as the "first flush", is directed to an Equalization Pond, and is normally pumped to the nitrogen products area for reuse in products. During heavier storms, after the "first flush", this water normally is discharged with plant effluents from the Clear Water Pond. In addition, storm water flows from the gas production area are discharged directly with effluents from the Clear Water Pond.

Clear Water Pond effluents combined with digester supernate and storm water from heavier storm events were monitored under the MISA Monitoring Regulation at Control Point CO0400.



Storm water from non-production areas, and overflows from the production areas that result in severe storm events, were monitored at MISA Control Point ST0500.

## 2.2 Wastewater Flow and Quality

Table A1 presents average, maximum and minimum flow and concentration data for those parameters considered to be "Priority 1" by the Ministry of the Environment for the MISA Control Point CO0400 at Nitrochem Inc.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following subsections.

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

### 3.1 BAT Option 1

Toxicity data collected, compiled and verified by the Ministry of the Environment for the first six months of the MISA Monitoring Regulation period are presented in Table A2. Seven tests on rainbow trout and six tests on Daphnia magna were all acutely lethal at concentrations less than 18 percent.

A review of Table A1 in the Appendix indicates that several contaminants in effluents monitored at CO0400 are at levels that might contribute to toxicity. The most obviously toxic pollutants are ammonia and pH. However, the synergistic or antagonistic effects of other contaminants such as nitrate, cyanide, phenols, metals and trace organics cannot be defined, but may also contribute to toxicity.

In the least cost case, only a minimum levels of pollutant control to achieve non-lethality is required. Therefore, only technologies for the reduction of ammonia and neutralization of pH to achieve non-toxic levels are recommended.

#### Ammonia

The plant has reported that over 90 percent of the ammonia loading in effluents is contributed from effluents from the Texaco Generator in the Hydrogen Plant. Ammonia present in this stream may be removed in a steam stripper, which would result in a high flow effluent with low ammonia concentration, and a residual concentrated ammonia stream available for reuse in the production of nitrogen products. This technology is recommended under BAT Option 1, and discussed in more detail in Section 4.

Calculations made in Section 4 indicate that effluent concentrations of 18 mg/L ammonia nitrogen will still remain after steam stripping. This concentration is significantly higher than the 48 hour LC50 concentration of 0.66 mg/L reported for Daphnia magna at 22 °C and 30 °C<sup>2</sup> (Ref. 2). Furthermore, at extreme temperature and pH conditions of 25 °C and 8.5 respectively, 15.3 percent, or 2.6 mg/L of unionized ammonia nitrogen would remain, compared to lethal concentrations of 0.63 mg/L (Ref. 3) and Ontario surface water quality objectives of 0.02 mg/L (Ref. 4).

Based on these comparisons, in-plant ammonia steam stripping alone would not produce non-lethal final effluents. Therefore, a global search was carried out to identify technologies for further reducing ammonia concentrations in wastewater. The following technologies were identified:

- Ion exchange
- Break point chlorination

---

<sup>2</sup> No pH values were reported

- Air stripping
- Biological nitrification.

**Air Stripping:** Air stripping was recommended by the U.S. EPA to follow steam stripping to achieve U.S. BAT effluent limits (Ref. 5). It was reported that better than 90 percent ammonia removal was achievable, resulting in effluent concentrations of less than 5 mg/L. A global search of technologies used in the ammonia manufacturing industry did not identify plants using air stripping. In the U.S., in 1979, no air strippers were known to be operating or planned at nitrogen fertilizer facilities (Ref. 6).

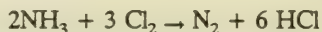
The air stripping process involves raising the pH of the water to 10.8 to 11.5 with lime to convert all ammonia to ammonium, formation and reformation of water droplets in a stripping tower, and providing air water contact and droplet agitation to enable transfer of ammonia to air, which is released to the atmosphere.

Several problems associated with air stripping have been identified as follows (Ref. 5, 6, 7):

- Low performance efficiencies in cold weather.
- High operating costs because of intense energy requirements.
- Calcium carbonate scaling as a result of lime addition.
- Cross media pollutant transfer; the ammonia is released to the atmosphere. Although technologies for ammonia recovery from air exist, they considerably increase the complexity and cost of the system.

On the basis of the above points, air stripping was not considered to be a demonstrated, practical control technology for treating the Nitrochem final effluent stream.

**Breakpoint Chlorination:** Breakpoint chlorination is the oxidation of ammonia with chlorine to result in the ultimate formation of nitrogen gas, following the overall reaction:



Theoretically, 7.6 mg/L of chlorine ( $\text{Cl}_2$ ) are required to oxidize 1 mg/L of ammonia-nitrogen.

Breakpoint chlorination has a long history of use in the chlorination of potable water supplies. It has also been used in the U.S. for minimizing the levels of unionized ammonia in effluents from other nitrogen removal technologies. However, several problems are potentially associated with the use of this technology in industrial wastewater treatment, including:

- Nitrate and nitrogen trichloride may be produced in the breakpoint chlorination reactions. Nitrate is another pollutant at nitrogen fertilizer facilities, while nitrogen trichloride exhibits a strong chlorinous odour, making its formation undesirable.
- Trihalomethanes and other chlorinated pollutants may be formed.
- Total dissolved solids levels may increase.
- Neutralization may be required to increase the pH after treatment. In addition, a dechlorination process to remove toxic chlorine residuals is required. Additional treatment steps increase the complexity of the system.
- Control of pH is critical to the performance of the process and to minimize nitrogen trichloride formation. Changing water quality make pH control difficult. Thus, reliability decreases during plant upsets.

In a global search, the use of breakpoint chlorination for reducing ammonia in nitrogen fertilizer plant effluents was not identified, nor was it recommended in the U.S. to achieve BAT effluent limits. Based on the above potential problems associated with breakpoint chlorination, it is not a recommended technology for reducing ammonia levels in Nitrochem ammonia plant effluents.

**Ion Exchange:** Selective ion exchange is a high-efficiency ammonia removal process for streams containing low TDS and ammonia concentrations. The waste stream is passed through a bed of ion exchange resin and functional groups attached to the resin exchange with ammonium ions in solution. Conventional ion exchange resins are not suitable for ammonia removal because most ions exchange preferentially to the ammonium ion. However, this limitation is overcome by using an exchange resin selective for ammonium, such as clinoptilolite, a common material found in bentonite deposits which removes ammonium ions from water preferentially to other cations.

The optimum exchange pH ranges from 4 to 8. Lower values result in excess hydrogen ions competing with the  $\text{NH}_4^+$  for exchange. At a high pH,  $\text{NH}_4^+$  is predominantly converted to  $\text{NH}_3$ , which will not exchange on the media. The process is insensitive to temperature fluctuations, but becomes less effective as ionic strength (TDS concentration) increases due to the effect of competing cation concentrations on the capacity of the media for ammonium (Ref. 8).

The exchange column can be regenerated with a sodium or calcium salt solution and the nitrogen can be recovered from the regenerant by air stripping, steam stripping, or electrolytic treatment.



Reported applications of selective ion exchange for ammonia removal include the treatment of municipal wastewaters having ammonia concentrations of about 25 mg/L. The U.S. EPA suggested ion exchange as an alternative treatment process to achieving BAT effluent limits in the nitrogen fertilizer industry (Ref. 5). In the global search carried out for this study, it was found that ion exchange was implemented in the 1970s at more than 10 nitrogen fertilizer facilities. However, currently only one process is remaining in operation. Operating problems that were encountered resulted in the discontinued use of this process<sup>3</sup> (Ref. 9). Based on these problems, this process is not recommended under BAT Option 4 for Nitrochem.

**Biological Ammonia Removal:** Biological ammonia removal is the natural conversion of ammonia to the less toxic nitrate ion. Nitrification takes place under aerobic conditions. Both suspended growth and fixed film systems are available, and ammonia removal greater than 90 percent is achievable.

Nitrification has been applied to treating ammonia nitrogen levels in industrial wastewaters with 30 to 700 mg/L (Ref. 10). One fertilizer industry in the U.S. uses aerobic lagoons to reduce ammonia, followed by denitrification in anoxic lagoons, to reduce nitrogen levels of 150 to 200 mg/L by up to 98 percent (Ref. 11).

Nitrification of Nitrochem effluents was selected under BAT Option 4 for additional removal of ammonia to achieve non-lethal effluents. This option is discussed in detail in Section 4.0.

## **pH**

Since the in-plant sources of high and low pH discharges are unknown, in-plant pH control methods were not identified. A pH adjustment system is required to neutralize flows, including storm water and Clear Water Pond effluents, prior to treatment in the nitrification system. Because pH adjustment may cause precipitation of some wastewater contaminants, and also, TSS levels are already high in effluents, sedimentation following pH adjustment is also included as a component of the system. The system is described in more detail in Section 4.0.

### **3.2 BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), Part 418 Fertilizer Manufacturing, limits were defined based on BAT for discharges from the manufacturing of ammonia, nitric acid and ammonium nitrate. These limits are presented in Table 1.

---

<sup>3</sup>

Details on operating problems collected by SAIC are currently unavailable.

**Table 1**  
**U.S. BAT Effluent Limits For Nitrogen Fertilizer Manufacturing**

	U.S. Effluent Limits	
	Maximum Day	Average Day
<b>Ammonia Manufacturing</b>		
Ammonia - N (kg/t/d) <sup>1</sup>	0.05	0.025
pH	6.0-9.0	6.0-9.0
<b>Ammonium Nitrate Manufacturing</b>		
Ammonia - N (kg/t/d)	0.08	0.04
Nitrate - N (kg/t/d)	0.12	0.07
<b>Nitric Acid Manufacturing</b>		
Ammonia - N (kg/t/d)	0.0045	0.00045
Nitrate - N (kg/t/d)	0.17	0.023
Notes:		
1. Kilogram of contaminant per tonne of production capacity per day.		

On a technology basis, Nitrochem exceeds U.S. BAT for wastewater treatment as defined in the U.S. Development Document (Ref. 5). Ammonia, nitric acid and ammonium nitrate processes do not discharge process effluents at all, as these are all used in the production of liquid nitrogen products.

Table 2 presents a comparison of U.S. BAT effluent limits for Nitrochem against actual effluent loading rates. This comparison is very conservative, because it includes loadings of process related contaminants such as ammonia and nitrogen also contributed from non-contact effluents such as cooling tower blowdown, boiler blowdown, etc. at Nitrochem which were specifically excluded from U.S. BAT effluent regulations.

Based on the comparison in Table 2, U.S. BAT limits for nitrate are generally met, although appeared to be exceeded on at least one day in the 12 month monitoring period. Because of the conservative approach used in the evaluation, it is assumed that no changes to nitrate control methods are required to meet U.S. BAT. Ammonia and pH limits defined by U.S. BAT were not met. With steam stripping of the Texaco generator stream, and neutralization and settling of the final effluent stream before discharge, as described under BAT Option 1, these limits would be met. Therefore, BAT Option 2 includes these technologies.

### **3.3      BAT Option 3**

There are two nitrogen fertilizer plants in the Ontario Inorganic Chemical Sector, including ICI Lambton Works and Nitrochem Inc., whose wastewater management can be



<p align="center"><b>Table 2</b>  <b>Comparison of U.S. BAT Effluent Limits to Effluent Loading from Nitrochem</b></p>				
Parameter	U.S. BAT		MISA Monitoring Period <sup>1</sup>	
	Maximum Day	30 Day Average	Maximum Day	12 Month Average
<b>Ammonia Manufacturing</b>				
Ammonia-N (kg/d)	13	6.5	.2	n.d.
pH	6.0-9.0	6.0-9.0	n.d.	n.d.
<b>Ammonia Nitrate Manufacturing</b>				
Ammonia-N (kg/d)	85	42.5	n.d.	n.d.
Nitrate-N (kg/d)	128	74.4	n.d.	n.d.
<b>Nitric Acid Manufacturing</b>				
Ammonia-N	4.0	0.4	n.d.	n.d.
Nitrate-N (kg/d)	150	20.3	n.d.	n.d.
<b>Total</b>				
Ammonia-N (kg/d)	102	49.4	303	96.8
Nitrate-N (kg/d)	278	94.7	343	85.7
pH (kg/d)	6.0-9.0	6.0-9.0	1.3-10.9	n.d.
<p>Notes:</p> <p>1. Based on 12-month data from MISA Control Point CO0400.</p> <p>2. No data - n.d.</p>				

compared on the basis of technologies and effluent quality (Ref. 1, Ref. 12).

### Technology

Both Ontario plants incorporate collection and reuse of process wastewater, including condensates and wash water, into liquid nitrogen fertilizer products. Thus, with the exception of select streams at both plants, process effluents are not discharged.

Different technologies for manufacturing nitrogen fertilizer products are used at each plant. However, in terms of wastewater control, the same overall results are achieved; that is reuse of wastewater discharges. Therefore, based on technologies alone, one process can not be considered more advanced than the other.

### Effluent Quality

A direct comparison of effluent quality at ICI and Nitrochem cannot be made, for the following reasons:

- Product lines and product capacities vary significantly between the two plants.

- Data for effluents from individual production units was not available for Nitrochem.
- Concentration data may not be compared directly because ICI incorporates a significant volume of once through cooling water which dilutes effluents, while Nitrochem does not.
- Contaminant loadings from the two plants are not significantly different from each other.

Therefore, observations in best demonstrated technologies may not be made on the basis of effluent quality.

### **Summary**

There is no clear indication as to which plant can be considered to be representing the best in the Province for wastewater control technology. Both plants manage water to minimize process discharges. Effluent quality in terms of loadings are not different by a significant factor, and since production capacities vary between the plants, it is difficult to draw a conclusion on this basis.

For the purposes of BAT Option 3, both Ontario nitrogen fertilizer plants are considered equivalent in terms of wastewater management, and therefore no changes to the Nitrochem system are included in this Option.

### **3.4 BAT Option 4**

BAT Option 4 includes technologies which provide the maximum overall pollution reduction at the plant.

Review of the effluent monitoring data at MISA Control Point CO0400 indicate several contaminant groups present in final plant effluents, including:

- Ammonia and TKN
- Nitrate and nitrite
- Phosphorus
- Cyanide
- pH
- Metals
- Oil and grease
- Phenolics and phenol
- Sulphide
- Chlorinated volatile organics and bromoform
- Dioxin and furan compounds

- PCBs
- Dissolved solids, including chloride, fluoride and sulphate.

Methods for reduction of each of these contaminants in effluents are discussed in the following sub-sections with respect to pollution prevention, and treatment.

### **3.4.1 In-plant Pollution Prevention**

Reduction of several of the contaminants identified in process effluents can be achieved by adopting a pollution prevention approach using in-plant controls.

#### **Phosphorus**

One source of phosphorus in effluents is phosphate based water treatment chemicals used to treat cooling tower and boiler make-up. Reduction of phosphorus levels could be achieved by using alternate treatment chemicals. However, because these would also contribute contaminants to final effluents, there may not be an overall improvement in water quality. Therefore, water treatment chemical changes are not recommended.

Raw materials at the plant used in the nitrogen products area include diammonium phosphate and ammonium polyphosphate, which are also potential sources of phosphorus in effluents. The means of contamination through contact with raw materials or products has not been identified, but is likely through storm water runoff or leaks and spills into process sewers leading to the Clear Water Pond. An audit of these sources are necessary, and control will be based on best management practices, likely through good house-keeping and spill control or diversion.

#### **Cyanide**

The only potential cyanide source identified at the plant is ammonium thiocyanate, a raw material used in the nitrogen products area. As above, an audit of point sources of contamination is necessary, and in-plant control will be based on best management practices to prevent contamination of storm water or Clear Water Pond effluents.

#### **Oil and Grease**

Oil and grease levels in the final effluent were generally at levels less than 3 mg/L, similar to raw water quality, although one high level of 900 mg/L was recorded over the MISA monitoring period. Best management practices for source control of oil and grease discharges are recommended to prevent occasional high discharges to effluent sewers.

## **Phenols**

A review of the raw materials and chemicals used at the plant indicate that there are several potential sources of phenolic compounds and phenol. These include fuels, general usage oil, and various petrochemical materials. A careful review of the plant processes did not reveal the specific source or mode of contamination.

A general review of the constituents of materials used at the plant to define specific phenol sources, and best management practices for control of the discharge from these sources is recommended under BAT Option 4.0.

## **Sulphide**

Low levels of sulphide were present in plant effluents measured at CO0400. The raw materials and chemicals used at the plant do not appear to be a potential source of sulphide contamination. Furthermore, it is most likely that sulphide is a contaminant in storm water as a result of air emissions, and not in plant effluents, such as cooling tower and boiler blowdown. Therefore, the source of sulphide should be investigated as part of a Storm Water Control Study, and technologies for its control are not recommended under BAT Option 4.

## **Chlorinated Organics and Bromoform**

Several volatile organic compounds were detected at mean effluent concentrations less than 45 µg/L. For contaminants with proposed Provincial surface water quality objectives and guidelines (PWQO/PWQG) (Ref. 4), levels detected in effluents were generally well below these limits, as shown in Table 3.

The chlorinated compounds detected are not uncommon to water supplies, such as municipal water, which are chlorinated to prevent algae and bacterial growth in systems, and result from the reaction of free chlorine with organic precursors in water. Their concentrations could be reduced or eliminated at source by improving TSS and turbidity removal from raw water to minimize available precursors, or by using an alternate disinfection chemical, such as bromine.

If improved TSS removal treatment were implemented, treatment chemicals for coagulation would be required, and would result in some residual chemicals in final effluents. Furthermore, disposal of treatment residuals (i.e. filter backwash water) would be required, adding another level of complexity and creating additional negative environmental impacts. As a result, this approach is not recommended to reducing the low levels of chlorinated volatile organics.



**Table 3**  
**Comparison of Volatile Organic Compounds in Nitrochem Effluents to Proposed PWQG/PWQO<sup>1</sup>**

Contaminant	Nitrochem Effluent Concentrations <sup>2</sup>		PWQG/PWQO (µg/L)
	Mean (µg/L)	Maximum (µg/L)	
Bromoform	4	29	60
Chloroform	3	12	-
Tetrachloroethylene	45	340	50
Trichloroethylene	2	10	2
Trans-1, 2-dichloroethylene	6	18	200
1, 1-Dichloroethane	1	3	200
1, 1-Dichloroethylene	2	4	40

Notes:

1. Ref. 4.
2. Data for 12 month MISA Monitoring Regulation period at CO0400.

An alternate water treatment chemical, such as bromine, could be considered. However, the potential for formation of halogenated organics may still exist, and other, potentially more toxic chemicals, could be added to the water with an alternate chemical. Therefore, because the relative benefits of using other water treatment chemicals for biocides are questionable, no changes to the existing system are recommended.

Since the chlorinated volatile organics concentrations are low, and waster treatment of other source control technologies may be associated with insignificant or negative environmental impacts, no recommendations for change are made.

Review of the materials used at the plant does not indicate the source of bromoform. Because levels are low, no in-plant measures for the reduction of this contaminant are recommended.

### Dioxin, Furan and PCB Compounds

A careful review of the processes discharging wastewater at Nitrochem was carried out to identify potential sources of dioxin, furan and PCB compounds. These pollutants are not commonly detected in cooling tower, boiler or compressor blowdowns as a result of normal operation or water treatment chemicals used in the process. Furthermore, materials used in the production of nitrogen fertilizer products do not normally contain these pollutants. And finally, the materials used at the plant, as described in the MISA Initial Report, do not appear to be potential sources for contaminants.

Nitrochem has undertaken a source identification study on dioxin and furan compounds. The plant have indicated that they suspect that cooling tower blowdown is the most likely source of these contaminants. Test results indicated the presence of these compounds in

the cooling water basin, aerobic pit, gas plant effluents and Clear Water Pond, with highest concentrations in the cooling water basin (Ref. 13).

Available test results have not indicated the precise source of the contamination, and it may be associated with raw water, water treatment chemicals, cooling tower construction materials, or other unidentified sources. Since the source has not been identified, in-plant controls cannot be recommended at this time.

### **Dissolved Solids and Metals**

Dissolved solids, including chloride, fluoride and sulphates, and several metals, were detected in effluents measured at CO0400. The main source of most of these contaminants is likely raw water, and they are present as a result of concentrating raw water in cooling tower and boiler water blowdown, and raw water treatment systems, such as the softener and various ion exchange resins. For metals or other dissolved solids contributed from these sources, practical opportunities for in plant source control or pollution prevention were not identified.

A vanadium source, other than raw water, may be vanadium pentoxide, a chemical used for water treatment in the Hydrogen Plant. Alternative treatment chemicals may be available, which do not contribute vanadium to effluents. However, a detailed review of available chemicals, and their associated environmental impacts would need to be undertaken to determine whether there are any advantages in overall pollution reduction by changing chemicals. Because vanadium levels were not generally excessive, and TSS removal will further reduce levels, in-plant changes are not recommended.

Copper present in effluents may also be contributed from corrosion of equipment such as heat exchangers. Copper levels in effluents were not generally excessive, and therefore, were not indicative of severe corrosion problems. Therefore, methods for in-plant control of copper was not identified.

A source of mercury in plant effluents was not identified. A review of plant processes and materials does not indicate a potential source of this contaminant. However, because it is not typically associated with nitrogen fertilizer production activities, its likely source is storm water contamination. Therefore, an audit of specific sources, and reduction through source control should be considered as part of a Storm Water Control Study.

### **Ammonia, Nitrate, TKN**

Several sources of ammonia, nitrate and TKN exist at the plant. The main source of ammonia has been identified by Nitrochem to be one process stream still being discharged (Ref. 1). Theoretically, since all process wastewaters except this one are reused in the



plant, there should be zero-discharge of process contaminants. This is, however, never the case at nitrogen fertilizer plants, because inadvertent leaks and spills into sewers, absorption of airborne ammonia in cooling towers, and contaminated runoff result in discharges of process contaminants to final effluents.

One method that has been proven successful at reducing process contaminant discharges at nitrogen fertilizer plants is the nitrogen-audit, which identifies point sources of contaminant releases. From the audit results, best management practices and process changes may be implemented to reduce discharge levels.

Within the scope of this study, point sources of contaminant discharges into sewers could not be identified, and therefore, in-plant pollution prevention measures were not developed. Furthermore, information gained from a comprehensive global search of nitrogen fertilizer facilities, suggests that there will always be a level of maximum contaminant reduction achievable through in-plant controls. In spite of these controls, process related contaminants will always be discharged, often at levels that are treatable with end-of-pipe technologies. For this reason, further pollution preventing measures at Nitrochem are not recommended to provide maximum reduction of process contaminants at Nitrochem.

#### 3.4.2 Treatment

The available, recommended methods for in-plant reduction of "Priority 1" pollutant discharges may not provide the maximum removal of these pollutants from effluents. Therefore, methods for removal through wastewater treatment were considered. These focus on removal of process contaminants, such as pH, ammonia and nitrate, but would also provide removal of other pollutants, as described in the following discussions.

For in-plant reduction of ammonia, steam stripping of the Texaco generator wastewater stream is recommended, as described under BAT Option 1.

A treatment system for the final effluent stream should be aimed at maximizing overall reduction of pollutants for which methods of elimination using in-plant pollution prevention approaches or treatment were not identified. Thus, the ideal treatment system would address:

- pH
- COD
- TSS and VSS
- Ammonia, TKN and nitrate
- Phosphorus
- Metals
- Volatile organic compounds
- Dioxin and furan compounds
- Total dissolved solids.

## **pH and TSS**

A system for pH adjustment includes neutralization followed by settling, for removal of precipitates formed during pH adjustment as well as TSS and VSS. With the pH reduction and settling of TSS, there will also be some removal of metals.

## **Metals**

Additional processes for metals reduction are not recommended. Relatively high mean levels of certain metals (Al, Cu, V, and Zn) shown in Table A1 for Control Point CO0400 were not representative of typical levels observed over the monitoring period. One very high result, occurring in the same month in which a sample with excessive TSS levels (17,000 mg/L) was measured, skewed the mean concentrations to be much higher than recorded for most months. Typical metals levels were at dilute concentrations, and practical technologies for removal of these from industrial wastewaters were not identified in a global search.

Technologies, were not identified for reducing mercury levels at less than 1 µg/L.

## **Ammonia and Nitrate**

With the implementation of the steam stripper on the Texaco Generator stream, final effluent ammonia levels should be reduced significantly. However, data on the quality of steam stripper effluent were estimated, to result in final effluent ammonia concentrations of 18 mg/L.

Nitrification has been recommended under BAT Option 1 to further reduce ammonia to nitrate for the purpose of reducing effluent toxicity. Biological denitrification, which takes place under anoxic conditions, following nitrification, will reduce nitrate to molecular nitrogen. The denitrification process can also be fixed film or suspended growth system, and a carbon source such as methanol must be available for the biological conversion. Details on the process are provided in a general technology report (Ref. 14).

Nitrification/denitrification is applicable to treating Nitrochem final effluents for removal of ammonia, nitrate and nitrite and TKN. This process offers many advantages, including the removal of the following pollutants in final effluents:

- COD
- Phenols
- Cyanide

- Phosphorus
- Volatile organics.

The details of a nitrification denitrification system for treating the Nitrochem final effluent measured at CO0400 are presented in Section 4.0.

### **Dioxin and Furan Compounds**

Dioxin and furan compounds are hydrophobic and have very strong tendencies to adsorb to organic matter and activated carbon, as indicated by measured log-octanol water coefficients greater than 6. For this reason, activated carbon treatment is a common technology used for removal of these compounds. However, one carbon system supplier has indicated that where solids are present, these compounds are often found in effluents due to TSS breakthrough (Ref. 15).

At Nitrochem, biological treatment for nitrogen removal is recommended under BAT Option 4. Because of the nature of dioxin furan compounds, they will become adsorbed to the biological flocculants. A study of 37 municipal wastewater treatment plants in Ontario found dioxin and furan compounds detected in final effluents at less than 10 percent of plants, but in treatment sludges at up to 65 percent of plants, at concentrations up to 4 orders of magnitude higher in sludges (Ref. 16). Based on these observations, it can be assumed that maximum contaminant removal will be achieved by maximum removal of biological floc, represented by TSS, after treatment. Since TSS levels are estimated to be relatively low (<25 mg/L) after treatment, a granular media filter is recommended for tertiary TSS removal.

### **Total Dissolved Solids**

Technologies for the removal of low levels of major dissolved solid contaminants present in Nitrochem effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

## **3.4.3 Summary**

BAT Option 4 includes the following recommended technologies for maximum reduction of pollutants in final effluent discharges from Nitrochem:

- Best management practices for source control of discharges of phosphates and thiocyanate resulting from raw materials used in the nitrogen products area.

- Best management practices for source control of phenol and oil and grease discharges.
- Steam stripping of hydrogen plant Texaco Generator wastewater stream, and reuse of concentrated ammonia residual stream in nitrogen products.
- End-of-pipe treatment including neutralization, settling, biological nitrogen removal, and granular media filtration.

### 3.5 BAT Option 5

Technologies that would advance the plant furthest toward zero-discharge of process related contaminants include all those recommended under BAT Option 4. Technologies for reduction or elimination of non-process streams such as water treatment residual streams, boiler blowdown, cooling tower blowdown were identified in a global search. However, a high level of treatment is required, aimed at total dissolved solids (TDS) removal to allow reuse of effluents. This treatment would include:

- Preconcentration of the waste stream using reverse osmosis, ion exchange or electrodialysis. Flow rates of residuals requiring further treatment will total approximately 10 to 30 percent of the original flow.
- Further concentration of the waste stream through evaporative technologies such as vapour compression evaporation or steam-driven evaporation.
- Crystallization of the concentration waste stream through the use of spray dryers or equivalent technologies.
- Disposal of resulting solid wastes.

Preconcentration technologies require careful control of operating conditions to avoid fouling or deterioration of membranes or resins and may require additional pretreatment steps such as removal of solids and/or organics. All of these technologies are both energy and labour intensive. These added operational and technological complexities are not likely to be offset by the improvements in wastewater quality which would result at Nitrochem. Thus, BAT Option 5 does not include measures for the control of dissolved solids.

Demonstrated systems for zero-discharge of nitrogen fertilizer industry effluents were not identified in the global search.

Process changes to eliminate discharges were also not identified. Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool process equipment in all manufacturing sectors including the nitrogen fertilizer industry. Other



cooling methods, such closed-loop air cooled systems, would require very large capital expenditures and land area for expansive heat exchange equipment requirements, and may not be effective in warmer months in Ontario. And finally, opportunities for consumption of plant effluents do not appear to exist in the production of any of the products produced at Nitrochem, since these are already consuming process effluents.

### 3.6 Summary

Table 3 presents a summary of BAT Options recommended for Nitrochem Inc.

<p style="text-align: center;"><b>Table 3</b> <b>Summary of BAT Options for Nitrochem Inc.</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	<ul style="list-style-type: none"> <li>• Steam stripping of Hydrogen Plant Texaco Generator effluents.</li> <li>• Neutralization, sedimentation and biological nitrification of final effluents.</li> </ul>
2	U.S. BAT	<ul style="list-style-type: none"> <li>• Steam stripping of Hydrogen Plant Texaco Generator effluents.</li> <li>• Neutralization and sedimentation of final effluents.</li> </ul>
3	Best demonstrated in Ontario	<ul style="list-style-type: none"> <li>• No change to existing system.</li> </ul>
4	Providing maximum pollutant reduction	<ul style="list-style-type: none"> <li>• Best management practices for source control of discharges of phosphorus and thiocyanate from raw materials.</li> <li>• Best management practices for source control of phenols and oil and grease.</li> <li>• Steam stripping of Hydrogen Plant Texaco Generator effluents.</li> <li>• End-of-pipe treatment, including neutralization, sedimentation, biological nitrification/denitrification and granular media filtration.</li> </ul>
5	Furthest towards zero-discharge of pollutants	

## 4.0 BAT OPTIONS

Estimated costs and performance of implementing BAT Options 1, 2, 4 and 5 are presented in the following sections. Under BAT Option 3, no changes to the existing system at Nitrochem were recommended.

### 4.1 BAT Option 1

BAT Option 1 includes steam stripping of Hydrogen Plant Texaco Generator effluents, and neutralization, sedimentation and biological nitrification of final effluents. Figure A1 in the Appendix presents a schematic of the final effluent treatment system.



#### 4.1.1 Steam Stripping

##### Description

A description of the steam stripping technology as applied to Nitrochem is presented in the General Technology Report (Ref. 17).

Nitrochem has prepared a preliminary design for a steam stripper for this application, which is presented in Table 4. The stripper would treat a combined stream, consisting of Hydrogen Plant Texaco Generator blowdown and process condensate. This stream has a reported average flow rate of 155 m<sup>3</sup>/d and an ammonia-nitrogen concentration of 560 mg/L.

**Table 4**  
**Nitrochem Inc. Steam Stripper Design Information<sup>1</sup>**

Design Parameter	Specification
Number of theoretical trays	7
Type of tray	Bubble tray/packed column
Height of tower	8.8 m
Diameter of tower	1.1 m
Pressure of steam	450 kPa
Temperature of steam	148 °C
Maximum flow of condensate to tower	164 m <sup>3</sup> /d
Flow of steam	900 kg/h

Source:

1. Ref. 17.

Associated with the steam stripper is a tube and shell condenser unit used to condense the ammonia-rich steam. Design specifications of this condenser are provided in Table 5. Nitrochem intends on using the condensed ammonia solution to make fertilizer.

##### Performance

Nitrochem estimates an average ammonia removal efficiency of 95 percent through the stripper. Table 6 presents the projected final effluent quality at CO0400 with implementation of the stripper. A final effluent ammonia concentration of 18 mg/L is projected.

**Table 5**  
**Nitrochem Inc. Condenser Unit<sup>1</sup>**

Design Parameter	Specification
Type of condenser	tube and shell
Cooling method	non-contact cooling water
Estimated rate of condensate production	0.32 m <sup>3</sup> /d
Cooling water usage	2,580 m <sup>3</sup> /d
Design rate of heat exchange	2.32 million kJ/h
Effective surface area of condenser	0.12 m <sup>2</sup>
Source:	
1. Ref. 17.	

**Table 6**  
**Projected Final Effluent Quality at Nitrochem with Implementation of Steam Stripper on Hydrogen Plant Effluents**

Parameter	Current Quality at CO0400 <sup>1</sup>	Projected Quality at CO0400 <sup>2</sup>	Loading Reduction
Ammonia-N			
• kg/d	97	14.3	85%
• mg/L	112	18	
TKN			
• kg/d	105	22.3	78%
• mg/L	122	28	
Notes:			
1. Mean data from 12 month MISA Monitoring Regulation period.			
2. Based on 95 percent removal of 87 kg/d ammonia-N from Texaco Generator effluents (155 m <sup>3</sup> /d). A small portion of ammonia at CO0400 may be contributed from other sources; however no information was available on this amount.			

## Costs

The total capital cost estimated for implementation of the steam stripper/condenser at Nitrochem is \$618,500 (ENR CCI 6343)<sup>4</sup>. Operating costs, based on \$4.60 per m<sup>3</sup> (Ref. 10)<sup>5</sup>, would be approximately \$260,000 per annum.

<sup>4</sup> Engineering News Record Construction Cost Index.

<sup>5</sup> Estimated from reported typical 1982 operating costs of \$12/U.S. gal (\$3.20/m<sup>3</sup>).

#### 4.1.2 pH Adjustment

##### Description

The reported pH levels for effluents from Nitrochem were often lower than the neutral range, but occasional high levels also occurred. A pH adjustment system will therefore include two chemical feed systems, including one for acid (e.g. hydrochloric acid solution) and one for caustic (e.g. soda ash slurry). An automatic feedback controller would be used to control the chemical dosage rates based on pH monitoring upstream and downstream of the chemical addition points. Small, continuous flow mix tanks are included at chemical addition points. Figure A1 in the Appendix presents a typical schematic of a pH adjustment system.

##### Performance

The pH adjustment system will produce effluents with a pH in the range of 6.5 to 8.5.

##### Costs

Capital costs of the neutralization system, presented in Table 7, are estimated to total \$240,000 (ENR CCI 6343). The main operating cost component will be chemicals. The quantity of chemicals cannot be calculated based on the available information.

<b>Table 7</b> <b>Estimated Capital Cost of Final Effluent Neutralization System</b>	
<b>Component</b>	<b>Cost<sup>1,2</sup></b>
Chemical storage tank, mix tank and feed systems	\$80,000
Continuous mix reactors	\$100,000
Instrumentation and controls	\$60,000
<b>Total</b>	<b>\$240,000</b>
Notes:	
1.	Includes 35 percent installation, 30 percent estimating contingency, 15 percent engineering and 7 percent G.S.T.
2.	ENR CCI 6343.

### 4.1.3

## Sedimentation and Equalization

### Description

Sedimentation of neutralized effluents is included in BAT Option 1 for the purpose of settling precipitates formed as a result of neutralization, as well as TSS, measured in final effluents at variable levels. In addition, equalization of flows is required to maintain stability of downstream biological nitrification system.

Because there appears to be sufficient land area on the south west corner of the site, settling lagoons were assumed for the purposes of costing. This type of system is generally less expensive than basins or clarifiers, and can be used both for flow equalization as well as settling.

For the basis of costing, the sedimentation/equalization lagoons at Nitrochem, the lined lagoon system used at an Ontario carbon black manufacturing facility, Cabot Canada Ltd., for treating final effluents, was used as a model (Ref. 18). The system would have the design features presented in Table 8. Two parallel ponds are included, so that solids can be removed from one pond while the second is in operation. The basins are designed to handle dry weather flows at a minimum weir height, and would have additional freeboard to store wet weather flows.

<p align="center"><b>Table 8</b> <b>Design Features of Sedimentation Equalization Lagoons at Nitrochem Inc.</b></p>	
Average flow rate	800 m <sup>3</sup> /d
Peak flow rate	4,900 m <sup>3</sup> /d
Average surface area (at peak flow)	64 m <sup>2</sup> /m <sup>3</sup> /d
Surface loading rate (at peak flow)	75 m <sup>2</sup>
Maximum weir height	4 m
Effluent discharge rate	1,000 m <sup>3</sup> /d (assumed)
Capacity	375 m <sup>3</sup>
Sidewall and berm slope	2:1
Land area required	2,500 m <sup>2</sup>
Number of ponds	2

The capacity requirements of the settling basin were estimated from historical Kingston area rainfall records, using a derived probability model (SUDS) (Ref. 19). The capacity estimates include rainfall that flows directly to the Clear Water Pond, from the gas plant area, but are probably less than required, because information was not available on volume and frequency of overflows from the Equalization Basin.

## Performance

The performance of the ponds will depend on the settleability of the TSS in pond effluents, and cannot be determined without jar tests. For the purpose of this study, it is assumed that 20 mg/L is achievable on a regular basis without chemical addition (other than upstream neutralizing chemicals) (Ref. 20). This performance or better could be achieved with the addition of coagulants or coagulant aids (e.g. alum, polymers). However, the need for these chemicals, and their impacts on effluent quality must be evaluated.

Settling will also reduce effluent concentrations of insoluble metal precipitates.

Table 9 presents the projected performance settling on selected target contaminants. An estimated 87 percent removal of TSS is achievable. In addition 16 to 60 percent metal removal efficiency is estimated, based on achieving mean metal concentrations reported for the one month of MISA monitoring with the lowest mean TSS concentration.

<p align="center"><b>Table 9</b> <b>Projected Performance Resulting from Final Effluent Sedimentation</b></p>			
Parameter	Current Quality at CO0400 <sup>1</sup>	Projected Quality at CO0400 <sup>2</sup>	Loading Reduction
TSS			
• kg/d	142	16	87%
• mg/L	199	20	
VSS			
• kg/d	14	1.9	87%
• mg/L	19	2.3	
Aluminum			
• kg/d	0.40	0.16	60%
• mg/L	594	206	
Copper			
• kg/d	0.035	0.02	43%
• mg/L	68.3	25.3	
Vanadium			
• kg/d	0.126	0.106	16%
• mg/L	200	133	
Zinc			
• kg/d	0.034	0.015	56%
• mg/L	52.9	18.5	
<p>Notes:</p> <p>1. Mean data from 12 month MISA Monitoring Regulation period at Control Point CO0400.</p> <p>2. Concentration data are monthly means from the one month during MISA Monitoring with lowest TSS concentrations (02/90). Loading data are based on mean monthly concentrations and 12 month mean flow rate.</p>			



## Costs

The estimated capital cost of the lined settling/equalization pond system, based on costs for the system at Cabot, are \$570,000 (ENR CCI 6343). The most significant portion of annual operating costs will be sludge disposal. This is estimated at \$350,000 per annum (1991), based on disposing of 52 tonnes of sludge per year, at five percent solids concentration at an estimated cost of \$350 per m<sup>3</sup> for disposal.

### **4.1.4      Nitrification**

#### Description

Nitrification involves biological oxidation of ammonia to nitrate under aerobic conditions. For the purposes of costing this process for Nitrochem, a nitrification system using fluidized bed reactor system was assumed. The general technology report presents details on this process. Other fixed film and suspended growth systems would produce similar effluent quality (Ref. 14).

Based on the design of the equalization system, an average nitrification system capacity of 1,000 m<sup>3</sup>/d was assumed.

#### Performance

Ammonia nitrogen removal efficiencies of greater than 99 percent have been reported in the literature (Ref. 14). This would result in an effluent ammonia concentration of <1 mg/L at MISA Control Point CO0400.

Biological floc would be settled and recycled. Effluent TSS levels are estimated to average less than 20 mg/L. Thus, there would be no net increase in TSS over the biological process.

## Costs

The estimated capital cost of an aerobic fluidized bed reactor system for treating Nitrochem effluents is \$2,600,000 (ENR CCI 6343). Annual operating costs are estimated at \$80,000 (Ref. 14).

### **4.1.5      Summary of BAT Option 1**

Table 10 presents a summary of the estimated costs and projected performance resulting from the implementation of BAT Option 1.

**Table 10**  
**Summary of Estimated Costs and Projected Performance of BAT Option 1**

Technology	Costs	Parameter	Current Loading at CO0400 (kg/d)	Projected Loading at CO0400 (kg/d)	Loading Reduction
Steam stripping of Hydrogen Plant Texaco Generator effluents	\$618,500 capital \$260,000/y operating	Ammonia-N TKN	97 105	Refer to nitrification	85% 78%
Neutralization	\$240,000 capital undefined operating	pH	1.3-10.9	6.5-8.5	-
Equalization/settling	\$570,000 capital \$350,000/y operating	TSS	142	16	87%
		VSS	14	1.9	87%
		Aluminum	0.40	0.16	60%
		Copper	0.035	0.020	43%
		Vanadium	0.126	0.106	16%
		Zinc	0.034	0.15	56%
Nitrification	\$2,600,000 capital \$80,000/y operating	Ammonia-N TKN Nitrate-N	14.3 <sup>1</sup> 22.3 <sup>1</sup> 85.7	<0.8 <8.8 >99.2	>94% >60% -16%
<b>Total</b>	<b>\$4,028,500</b> <b>\$690,000/y</b>				
Notes:					
1. Effluent loading after upstream steam stripping.					

## 4.2 BAT Option 2

### Description

A schematic of the processes included in BAT Option 2 is presented in Figure A2. BAT Option 2 incorporates in-plant steam stripping and neutralization and settling of final effluents, as described in Section 4.1. Because nitrification is not included in this option, flow equalization is not required and therefore, settling basins are significantly smaller. The estimated design features of these basins are presented in Table 11.

### Costs and Performance

Removal of target contaminants for each of the technologies included in BAT Option 2 was described in Section 4.1. The implementation of the stream stripper will result in effluent ammonia nitrogen levels of 14.3 kg/d compared to 49.4 kg/d defined by U.S. BAT.

With the exception of the settling lagoons, costs are the same as those presented in Section 4.1. The settling lagoon capital costs are less because additional capacity is not

**Table 11**  
**Design Features of Sedimentation Lagoons for Nitrochem Inc.**

Component	Value
Average flow	800 m <sup>3</sup> /d
Peak flow	4,900 m <sup>3</sup> /d
Surface loading rate (peak)	64 m <sup>3</sup> /m <sup>2</sup> /d
Surface area	75 m <sup>2</sup>
Number of ponds	2 @ 75 m <sup>2</sup>
Weir height	0.7 m
Sidew	2:1
all and berm slope	850 m <sup>2</sup>
Land area required	

required for flow equalization.

Table 12 summarizes BAT Option 2 costs and performance.

**Table 12**  
**Summary of Estimated Costs and Projected Performance for BAT Option 2**

Technology	Costs	Parameter	Current Loading at CO0400 (kg/d)	Projected Loading at CO0400 (kg/d)	Loading Reduction
Steam stripping of Hydrogen Plant Texaco Generator effluents	\$618,500 capital \$260,000/y operating	Ammonia-N TKN	97	14.3	85%
			105	22.3	78%
Neutralization	\$240,000 capital undefined operating	pH	1.3 - 10.9	6.5 - 8.5	-
Settling	\$250,000 capital \$350,000/y operating	TSS	142	16	87%
		VSS	14	1.9	87%
		Aluminum	0.40	0.16	60%
		Copper	0.035	0.020	43%
		Vanadium	0.126	0.106	16%
		Zinc	0.034	0.015	56%
Total Cost	\$1,110,000 capital \$610,000/y operating				

#### 4.3 BAT Options 4 and 5

BAT Options 4 and 5 include best management practices for source control of phosphorus and thiocyanate from raw waters, and for control of oil and grease and phenols discharges. Treatment technologies recommended under these Options include steam stripping of the Texaco Generator effluents, as well as neutralization and settling, as described for BAT Option 1. In addition, biological nitrogen removal by nitrification and

denitrification is recommended for treating settling pond effluents. A granular media filter is included following the biological system for maximum removal of dioxin and furan compounds adsorbed to biological floc. A schematic of the recommended final effluent treatment system is presented in Figure A3.

#### **4.3.1      Best Management Practices for Control of Raw Material Contamination**

##### **Description**

A detailed review of current raw materials and handling practices is necessary to establish where contamination of discharges is occurring, and to identify control measures. These may include:

- Containment of raw materials storage areas.
- Routine inspection of storage containers for leaks.
- Maintaining control on raw materials handling, including provision of routine handling procedures, as well as procedures for spill prevention and clean-up.
- Good housekeeping.

##### **Performance**

Complete elimination of raw materials contamination should result with a comprehensive program of source controls. Contaminant removal cannot be estimated, since raw materials may not be the only source of the target pollutants, phosphorus and cyanide.

##### **Costs**

Costs of best management practices cannot be estimated until source control measures are defined. These cost are expected to be small.

#### **4.2.2      Best Management Practices for Control of Oil and Grease and Phenols Contamination**

##### **Description**

Best management practices for control oil and grease discharges cannot be specifically identified without a detailed understanding of the plant, and potential sources. Some general procedures that could be considered include:



- Good housekeeping and prevention of materials spills and leaks.
- Containment of high risk oil leak or spill locations.
- Placing oil absorbent pads or socks around equipment.
- Using oil absorbent pads in wastewater collection sumps to absorb visible oil sheens.
- Other methods, depending on nature of discharge.

Phenols detected at the plant may in part be associated with oil and grease contamination. However, because oils and grease levels were low, other phenols sources are indicated. An audit of potential sources is recommended, and best management practices as described above are recommended for control.

### Performance

Oil and grease effluent concentrations were generally less than 3 mg/L over the 12 month MISA Monitoring Regulation period. One high month, skewed the reported mean level. If best management practices were implemented, excessive levels should not occur. Table 13 presents the projected reduction in oil and grease levels.

Table 13 Projected Performance Resulting From Implementation of Best Management Practices for Oil and Grease Control			
Parameter	Current Quality at CO0400 <sup>1</sup>	Projected Quality at CO0400	Loading Reduction
Oil and Grease			
• kg/d	15.7	2.1 <sup>2</sup>	87%
• mg/L	20.4	2.7 <sup>3</sup>	
Notes:			
1. Mean data from 12 months MISA monitoring at CO0400.			
2. Calculated from mean concentration and 12 month mean flow rate.			
3. Average oil and grease concentration measured at CO0400 over 11 months of MISA monitoring and excludes 1 month with excessive oil and grease levels (900 mg/L).			

Theoretically, complete elimination of phenols from effluents contributed from materials used at the plants should be achievable through source control. However, because the sources of this pollutant may include those other than materials used at the site (e.g. storm water runoff, contaminated seepage, etc.) performance for source control cannot be calculated.



## Costs

Costs of best management practices cannot be estimated until source control methods are defined. These costs are expected to be small.

### **4.3.3      Settling, Equalization and Biological Nitrogen Removal**

#### **Description**

Biological nitrogen removal in a two stage process involves oxidation of ammonia to nitrate (nitrification), followed by reduction of nitrate to nitrogen, nitrous oxide (denitrification) or nitric oxide. The first stage was recommended under BAT Option 1. The second stage takes place under anoxic conditions and with a carbon source (e.g. methanol).

For the purposes of costing this technology for Nitrochem, a nitrification denitrification system using fluidized bed reactors was assumed. The general technology report presents details on this process. Other fixed film and suspended growth systems would produce similar effluent quality (Ref. 14).

Because the effluent flows at Nitrochem vary widely, equalization of flow upstream of the reactor is recommended using the same system described under BAT Option 1 in Section 4.1.3. The denitrification system, following nitrification will have the same assumed capacity of 1,000 m<sup>3</sup>/d.

#### **Performance**

Removal efficiencies have been measured for several contaminants, including ammonia, cyanide and phenols, over the entire nitrification/denitrification system (Ref. 14). Based on the literature data, contaminant removal performances of the system treating Nitrochem effluents were calculated, and are presented in Table 14.

## Costs

Estimated cost for the neutralization, settling and end-of-the pipe treatment system are presented in Table 15. The total capital cost is estimated to be \$4,480,000 (ENR CCI 6343).

Operating costs for the nitrification/denitrification system include oxygen, chemicals, methanol and sludge disposal. Total operating costs are estimated at greater than \$530,000 per annum (1991).

**Table 14**  
**Projected Performance Resulting from the Implementation of**  
**Nitrification/Denitrification**

Parameter	Estimated Nitrification/ Denitrification Influent Quality	Estimated Removal Efficiency <sup>1</sup>	Projected Effluent Quality at CR0400
Ammonia-N • (kg/d) <sup>2</sup> • (mg/L) <sup>2</sup>	14.4 18	99.3%	<0.02 <1
Nitrate-N • (kg/d) • (mg/L)	86 92.4	<5 mg/L	4.0 <5
TKN • (kg/d) • (mg/L)	22.3 28	95.2%	1.1 1.3
Phenols • (kg/d) • (mg/L)	0.051 86	>99.9%	<0.00
Total Cyanide • (kg/d) • (mg/L)	0.20 0.32	91% <sup>3</sup>	0.02 0.03
Notes:			
1. Ref. 14.			
2. Estimated mean quality after upstream treatment.			
3. Assumes total cyanide primarily in the form of thiocyanate.			

**Table 15**  
**Capital and Operating Costs of End-of-Pipe Treatment System**

Component	Capital Cost <sup>1</sup>	Annual Operating Cost (\$1991)
Neutralization	\$240,000	undefined
Settling/equalization lagoons	\$570,000	\$350,000
Nitrification/denitrification system	\$3,670,000	\$180,000
<b>Total</b>	<b>\$4,480,000</b>	<b>&gt;\$530,000</b>
Notes:		
1. ENR CCI 6343.		

#### 4.3.4 Tertiary Effluent Filtration

##### Description

Biological floc, measured as TSS, formed in the biological treatment system will be the adsorbent for dioxin furan compounds. Waste floc will be settled and sludge disposed.

However, some biomass residual will remain in effluents. Therefore, granular media filtration is recommended after the biological system for maximum TSS removal, and dioxin and furan removal from effluents.

For the purposes of costing, two gravity fed rapid sand filter columns were assumed. Each column would be sized for the effluent flow rate of 1,000 m<sup>3</sup>/d. Columns would operate in parallel, and during backwashing of one column, the other column would filter the entire flow. Backwash water would be returned to the equalization/settling basin.

Table 16 presents the estimated design features of the sand filter system.

<b>Table 16</b> <b>Design Features of Rapid Sand Filtration System<sup>1</sup></b>	
<b>Component</b>	<b>Value</b>
Filtration rate	2.1 L/m <sup>2</sup> S
Surface area	5.5 m <sup>2</sup>
Diameter	2.6 m
Solids loading rate <sup>2</sup>	42 mg/m <sup>2</sup> .S
Number of filters	2
Bed depth	
- sand	0.8 m
- gravel	0.4 m
<b>Notes:</b>  1. Based on typical values presented in Ref. 21. 2. Assuming 20 mg/L TSS in filter influent.	

## Performance

Mean effluent TSS concentrations of 5 mg/L are achievable when filtration of biological floc is used. Documented performance data for removal of dioxin and furan compounds from effluents using biological floc removal were not identified in a global literature search. Based on the theoretical sludge production rate (Ref. 14), 60 mg/L of biological floc produced per day will be reduced by 92 percent through settling and filtration. Thus, an estimated 92 percent removal of dioxin furan compounds is estimated.

## Costs

The estimated capital costs for implementing two granular media filters with the details identified in Table 16 is \$1,520,000. Operating costs would not significantly increase those of the end-of-pipe treatment system.

### 4.3.5 Summary

Table 17 presents a summary of the estimated costs and projected performance resulting from the implementation of BAT Option 4 and 5.

Table 17 Summary of Projected Cost and Estimated Performance of BAT Options 4 and 5					
Technology	Costs	Parameter	Current Loading at CO0300 (kg/d)	Projected Loading at CO0300 (kg/d)	Loading Reduction
Steam stripping of Hydrogen Plant Texaco Generator effluents	\$615,500 capital \$260,000/y operating	Ammonia	97	<0.2	>99.8%
		TKN	105	1.1	99%
		Nitrate-N	86	4.0	95%
		pH	1.3-10.9	6.5-8.5	-
Best management practices for oil and grease control	undefined	TSS	142	5	96%
		VSS	14	0.6	96%
		Aluminum	0.40	0.16	60%
		Copper	0.035	0.20	43%
Best management practices for control of raw materials contamination	undefined	Vanadium	0.126	0.106	16%
		Zinc	0.034	0.015	56%
		Oil & grease	20	2.1	90%
		Cyanide	0.20	0.02	91%
Neutralization	\$240,000 capital undefined operating	Phenolics	0.051	<0.00	>99.9%
		Total H6CDF (mg/d)	0.019	0.002	92%
		Total H7CDD (mg/d)	0.176	0.014	92%
		Total H7CDF (mg/d)	0.050	0.004	92%
Settling	\$570,000 \$350,000/y operating	Octachlorodibenzodioxin (mg/d)	0.606	0.048	92%
		Octachlorodibenzofuran (mg/d)	0.030	0.0002	92%
Nitrification/Denitrification	\$3,670,000 capital \$180,000/y operating				
Filtration	\$1,520,000 capital insignificant operating				
Total Cost	\$6,616,000 capital \$790,000 operating				

## 5.0 SUMMARY OF BAT OPTIONS

Table 18 presents a summary of costs and performance estimated for implementation of BAT Options recommended for Nitrochem Inc.

## 6.0 REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report, Nitrochem Inc. May 2 and 3, 1991 (unpublished).

**Table 18**  
**Summary of Estimated Costs and Projected Performance of BAT Options**

Component	BAT Option 1	BAT Option 2	BAT Option 3	BAT Options 4 and 5
<b>Cost</b>				
Capital	\$4,028,500	\$1,110,000	\$0	\$5,100,000
Operating	\$690,000/y	\$610,000/y	\$0	\$790,000/y
<b>Loading Reduction</b>				
Ammonia-N (kg/d)	>96	83	0	>96
TKN (kg/d)	104	83	0	104
Nitrate-N (kg/d)	-13.5	0	0	84
pH	6.5-8.5	6.5-8.5	1.3-10.9	6.5-8.5
TSS (kg/d)	126	126	0	137
VSS (kg/d)	12.1	12.1	0	13.4
Aluminum (kg/d)	0.24	0.24	0	0.24
Copper (kg/d)	0.015	0.015	0	0.015
Vanadium (kg/d)	0.020	0.020	0	0.020
Zinc (kg/d)	0.019	0.019	0	0.019
Oil and Grease (kg/d)	0	0	0	17.9
Cyanide (kg/d)	0	0	0	0.18
Phenolics (kg/d)	0	0	0	0.051
Total H6CDF (mg/d)	>0	0	0	0.017
Total H7CDD (mg/d)	>0	0	0	0.162
Total H7CDF (mg/d)	>0	0	0	0.046
Octachlorodibenzodioxin (mg/d)	>0	0	0	0.558
Octachlorodibenzofuran (mg/d)	>0	0	0	0.028

2. R.V. Thurston, R.C. Russo. Ammonia Toxicity to Fishes. Effect of pH on the Toxicity of the Un-ionized Ammonia Species, Environmental Science and Technology. Vol 15, No. 7, July, 1981.
3. Water Quality Criteria for European Fresh Water Fish, Water Research, Vol. 7, 1973.
4. Proposed Ontario Provincial Water Quality Guidelines and Objectives. Ontario Ministry of the Environment. April 23, 1991.
5. Development Document for Effluent Limitations Guidelines and New Source Performance Standards for the Basic Fertilizer Chemicals Segment of the Fertilizer Manufacturing Point Source Category. U.S. EPA Report EPA - 440/1-74-001-a. March 1974.
6. An Evaluation of Control Needs for the Nitrogen Fertilizer Industry. U.S. EPA Report EPA-6/2-79-186. August 1979.



7. Process Design Manual for Nitrogen Control. U.S. EPA Technology Transfer. October 1975.
8. J.H. Koon, W.J. Kaufmann. Ammonia Removal from Wastewater by Ion Exchange. Journal of Water Pollution Control Federation, Volume 47, 1975.
9. Telephone conversation with Irwin Higgins of Lake Industries Inc., Oakridge, Tennessee. July 1991.
10. J.W. Patterson. *Industrial Wastewater Treatment Technology Second Edition*. Butterworth-Herrenkott. 1985.
11. Telephone conversation with Roy Dugan of Air Products and Chemicals Inc., Pensacola. April 1991.
12. Inorganic Chemical Sector Plants Site Visit Report, ICI Nitrogen Products, Lambton Works.
13. Correspondence from Iyasu Burru at Nitrochem to the Ministry of the Environment, September 24, 1990.
14. General Technology Report Biological Nitrogen Removal.
15. Telephone conversation with Paul Boron of Calgon. November, 1991.
16. Thirty Seven Municipal Water Pollution Control Plants Pilot Monitoring Study. Report prepared by CH2M HILL for the Ontario Ministry of the Environment. July 1989.
17. General Technology Report for Cooling Tower and Boiler Water Make-up Treatment Chemicals.
18. General Technology Report Ammonia Removal by Steam Stripping for Nitrochem Inc.
19. Sister Plant Technology Report Coagulation/Settling/Filtration Ponds at Cabot Canada Ltd.
20. Design Guidelines for Water and Sewage Treatment Plants. Ontario Ministry of the Environment Report. April 1982.
21. Adams, B.J., and Bontje, J.B. *Microcomputer Applications of Analytical Models for Urban Storm Water Management*. Engineering Foundation Conference on Emerging Computer Techniques in Storm Water and Flood Management, 1985.
22. General Technology Report Settling/Sedimentation for TSS Removal.

## **APPENDIX**

### **Tables and Figures**



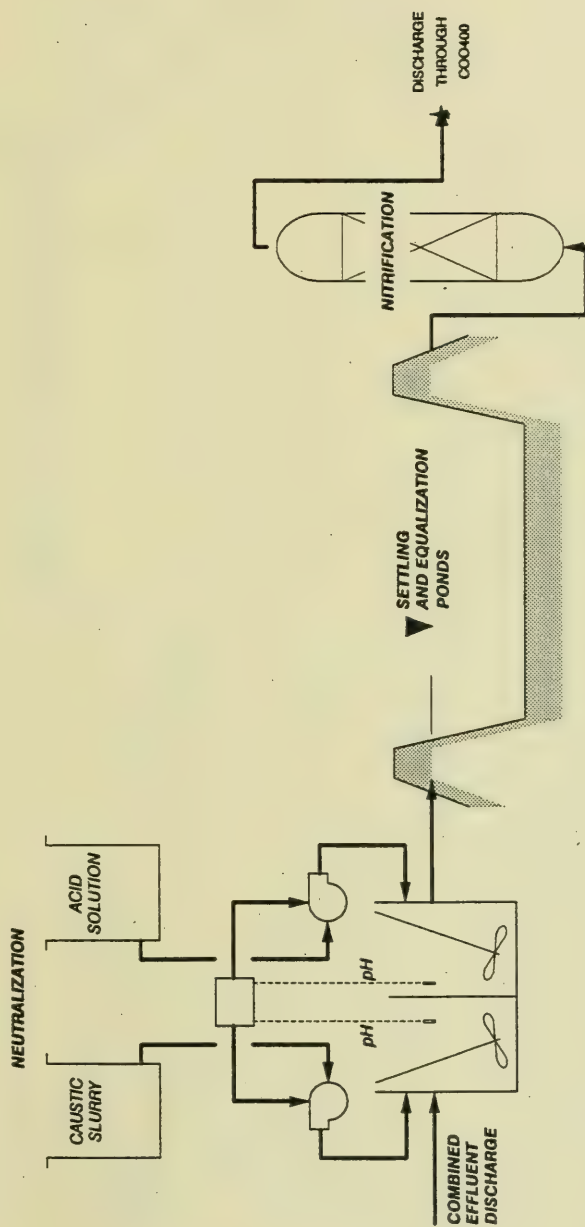
**Table A1, Nitrochem Inc., Maitland**  
**Summary of Flows and Priority One Pollutants**  
**MISA Control Point: CO0400**  
**Description: Combined - Final Effluent**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	229	4900	798	
COD	mg/L	66	83	73.2	47.065
Cyanide Total	mg/L	0.013	0.91	0.321	0.196
Hydrogen Ion (pH)		1.32	3080	17.8	
Ammonia Plus Ammonium	mg/L	28	380	112	96.837
Total Kjeldahl Nitrogen	mg/L	0.16	410	122	105.221
Nitrate and Nitrite	mg/L	0.92	430	92.4	85.708
DOC	mg/L	14	160	32.6	19.526
TOC	mg/L	14	140	30.9	18.656
Total Phosphorus	mg/L	0.069	7.3	1.36	0.877
Specific Conductance	uS/cm	640	38000	390	
Total Suspended Solids	mg/L	4.2	17000	199	142
VSS	mg/L	11		18.8	14.378
Aluminum	ug/L	9	9000	594	0.402
Boron	ug/L	6	180	106	0.073
Copper	ug/L	6	960	68.3	0.035
Strontium	ug/L	120	380	266	0.195
Vanadium	ug/L	15	3200	200	0.126
Zinc	ug/L	4	1500	52.9	0.034
Mercury	ug/L	0.019	0.34	0.168	0
Phenolics (4AAP)	ug/L	11	370	85.5	0.051
Sulphide	ug/L	19	170	84.8	0.045
Bromoform	ug/L	0.37	29	3.99	0.002
Chloroform	ug/L	0.4	12	2.95	0.002
Tetrachloroethylene	ug/L	0.2	340	44.5	0.026
Trichloroethylene	ug/L	0.3	9.5	2.35	0.002
Trans-1,2-Dichloroethylene	ug/L	0.4	18	6.13	0.005
1,1-Dichloroethane	ug/L	0.5	2.9	1.08	0.001
1,1-Dichloroethylene	ug/L	0.4	4.1	1.88	0.001
Phenol	ug/L	1.1	85	13.8	0.008
Total H6CDF	pg/L	15	74	24.4	0
Total H7CDD	pg/L	17	530	220	0
Total H7CDF	pg/L	20	170	62.6	0
Octachlorodibenzo-p-dioxin	pg/L	20	1500	760	0
Octachlorodibenzofuran	pg/L	22	81	37.2	0
Oil and Grease	mg/L	0.96	901	20	15.695
PCBT	ug/L	0.05	12	0.377	0
Chloride, Unfiltered Reactive	mg/L	52	140	97	56.878
Fluoride, Unfiltered Reactive	mg/L	0.2	0.4	0.275	0.157
Sulphate, Unfiltered Reactive	mg/L	230	860	518	294

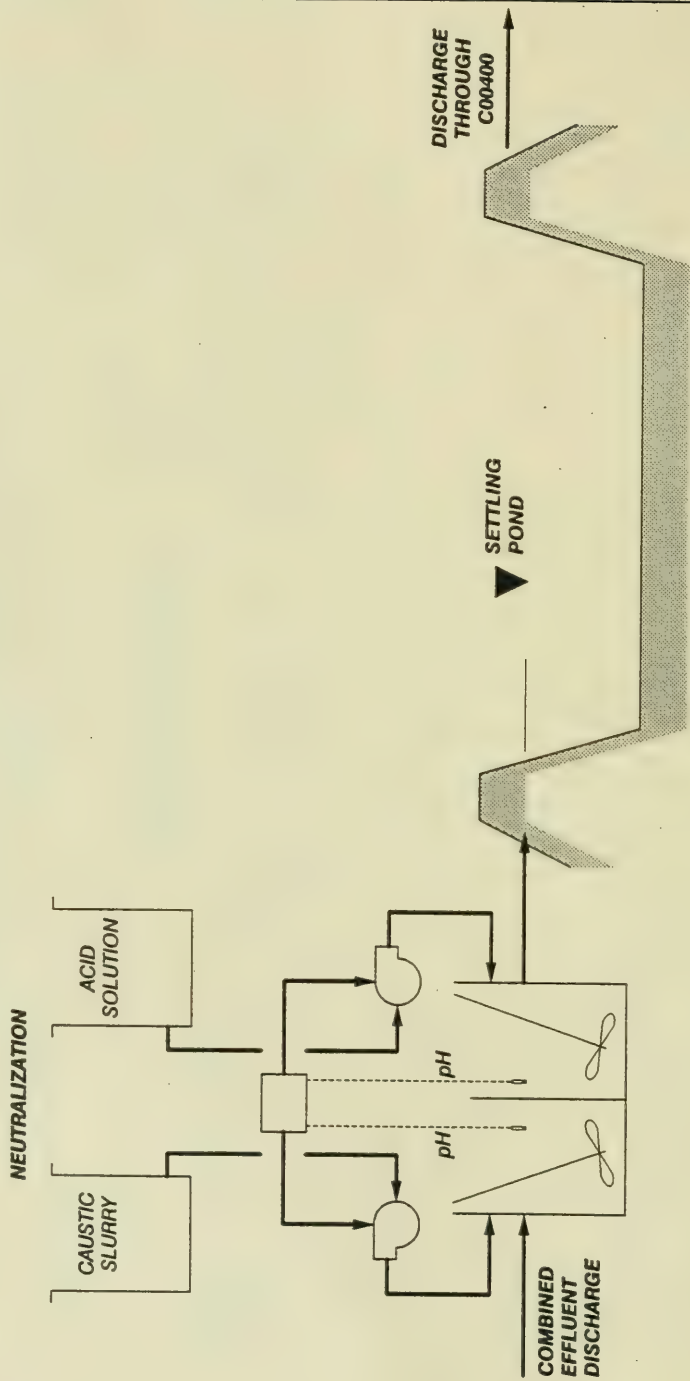
**Table A2**  
**Toxicity Data for Nitrochem Inc. for the First Six Months of the MISA Monitoring**

Control Point	Test Species	Number of Samples	Range of Data	Number of Non-lethal Samples
CO0400	Rainbow trout	7	2.4% to 14.1%	0
	<u>Daphnia magna</u>	6	3.1% to 17.2%	0

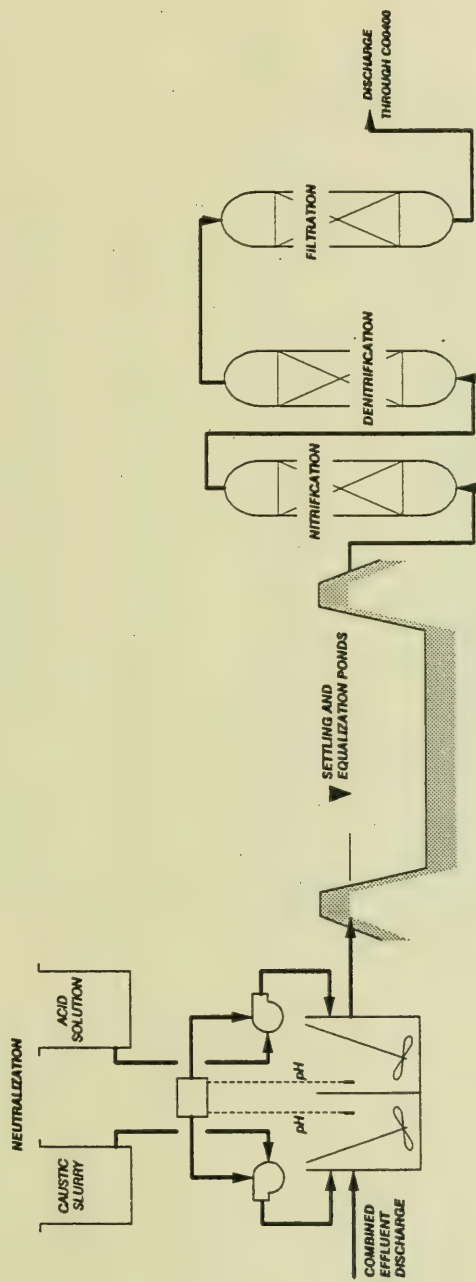




**Figure A1**  
**END OF PIPE TREATMENT SYSTEM**  
**RECOMMENDED UNDER BAT OPTION 1**



**Figure A2**  
**END OF PIPE TREATMENT SYSTEM**  
**RECOMMENDED UNDER BAT OPTION 2**



**Figure A3**  
**END OF PIPE TREATMENT SYSTEM**  
**RECOMMENDED UNDER BAT OPTIONS 4 & 5**

Nitrochem  
Maitland

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS		LOADINGS kg/day	
				CO 0400	IN 0800	CO 0400	IN 0800
c	Total suspended solids	5	mg/L	199	4.2	197	3.35
c	Hydrogen ion (pH)			9.63	7.94		
c	Specific conductance		uS/cm	3390	315		
c	DOC	0.5	mg/L	32.5	1.6	21.8	1.28
c	TOC	5	mg/L	30.9		20.5	
c	Oil and grease	1	mg/L	20.4	1.53	1.81	1.22
c	Ammonia plus Ammonium	0.25	mg/L	112	14.9	102	11.9
c	Nitrate+Nitrite	0.25	mg/L	92.4	22.6	90.2	18
c	Total Kjeldahl nitrogen	0.5	mg/L	122	7.7	108	6.15
c	Total phosphorus	0.1	mg/L	1.36	0.069	1.09	0.055
09	Aluminum	30	ug/L	594	33	0.558	0.026
09	Boron	50	ug/L	106	21	0.086	0.017
09	Copper	10	ug/L	56.3	2	0.044	0.002
09	Strontium	20	ug/L	267	156	0.238	0.125
09	Vanadium	30	ug/L	200	3	0.14	0.002
09	Zinc	10	ug/L	52.9	4	0.041	0.003
12	Mercury	0.1	ug/L	0.168	0.019	—	—
14	Phenolics (4AAP)	2	ug/L	85.5	1	0.058	0.001
15	Sulphide	20	ug/L	84.8	40	0.021	0.032
16	1,1-Dichloroethane	0.8	ug/L	1.08	0.5	0.001	—
16	1,1-Dichloroethylene	2.8	ug/L	1.88	0.4	0.001	—
16	Bromoform	3.7	ug/L	3.99	0.37	0.003	—
16	Chloroform	0.7	ug/L	2.95	0.4	0.001	—
16	Tetrachloroethylene	1.1	ug/L	44.5	0.2	0.027	—
16	Trans-1,2-Dichloroethylen	1.4	ug/L	6.13	0.4	0.005	—
16	Trichloroethylene	1.9	ug/L	2.35	0.3	0.002	—
17	Benzene	0.5	ug/L	0.2	0.85	—	0.001
17	Toluene	0.5	ug/L	0.4	1.6	—	0.001
20	Phenol	2.4	ug/L	13.8	1.1	0.011	0.001
24	Octachlorodibenzo-p-diox	30	pg/L	760	20	—	—
24	Octachlorodibenzofuran	30	pg/L	37.2	22	—	—
24	Total H6CDF	20	pg/L	24.4	15	—	—
24	Total H7CDD	30	pg/L	220	17	—	—
24	Total H7CDF	30	pg/L	62.6	20	—	—
2	Cyanide Total	0.005	mg/L	0.321	0.001	0.024	0.001
27	PCBT	0.1	ug/L	0.377	0.05	—	—
98	Ftflow		m3/d	798			
11	Chloride	2	mg/L	97	21	60.1	16.8
12	Fluoride	0.1	mg/L	0.275	0.100	0.163	0.080
13	Sulphate	5	mg/L	518	25	335	20

Notes

CO0400 is the "Final Effluent" which discharges into the St. Lawrence River.

Flow value and loadings are of uncertain accuracy due to incorrect flow monitoring device settings.

## **APPENDIX 17**

**Norton Advanced Ceramics of Canada Inc.**





**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
NORTON ADVANCED CERAMICS OF CANADA INC.**

**1.0        PLANT DESCRIPTION**

Norton Advanced Ceramics, Niagara Falls, produces a range of fused alumina manufactured abrasives. Molten aluminum oxide is formed in an electric arc furnace through the melting of bauxite, coke and iron borings. Other raw materials include sulphur, calcined alumina, sulphuric acid, magnesium oxide, baddeleyite (a zirconium-bearing mineral) and chromic oxide, depending on the abrasive being produced. The molten product is poured, cooled and solidified prior to crushing, grinding and the size classification required for sale. In the production of light and dark fused alumina, by-product ferro-silicon is periodically poured from the furnace and is also solidified, crushed and sold when markets exist.

The process involves the use of water for contact cooling as well as product finishing. Water for the site is drawn from the nearby Welland River.

Details on plant production processes and wastewater management are provided in the site visit report (Ref. 1).

**2.0        WASTEWATER SOURCES AND QUALITY**

**2.1        Wastewater Sources**

There are three sources of process related effluent at the plant:

- Contact cooling water from sumps collecting drainage from furnace areas.
- Process water from slaking, screening, acidification/de-acidification and hydro-classification of the Alundum<sup>®</sup>32 product.
- Process water from the milling/screening/washing operation for the alumina zirconia product.

Non-process related effluents consist entirely of storm water collected from the plant site.

Four outfalls were monitored under the MISA monitoring regulation. Wastewater sources for these four outfalls are described below:

- MISA Control Point CO0200
  - Contact cooling water (sump overflow) which has been treated in a settling basin.
  - Untreated storm water from the northeast border of the plant site.
- MISA Control Point CO0300
  - Contact cooling water (sump overflow) which has been treated in a settling basin.
  - Process wastewater from the Alundum<sup>R</sup>32 plant which has been treated with lime addition and settling in lined lagoons.
- MISA Control Point CO0400
  - Contact cooling water (sump overflow) and process wastewater from the alumina zirconia plant which has been treated in a settling basin.
- MISA Control Point ST0600
  - Untreated storm water from the remainder of the plant site.

Intake water from the Welland River was also monitored as MISA Control Point IN0800 during the regulation monitoring period.

## 2.2 Wastewater Flows and Quality

Tables A1 to A3 in the Appendix present average, maximum and minimum flow and concentration data as well as average daily loading for those contaminants defined by the Ministry of the Environment as "Priority 1" for MISA Control Points CO0200, CO0300 and CO0400.

In accordance with the study requirements, five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

### **BAT Option 1**

Toxicity data collected and compiled for the first six months of the MISA monitoring period by the Ministry of the Environment are presented in Table A4. At MISA Control Points CO0200 and CO0400, seven tests on each of trout and Daphnia magna did not result in more than 50% mortality of the test species, resulting in LC50s of >100 percent to non-lethal. Thirteen of the 28 tests on these two effluents yielded no lethality.

For MISA Control Point CO0300, toxicities were somewhat higher. For trout, five of the seven tests were non-lethal, within LC50s ranging from 75% to non-lethal. For Daphnia magna, two of six tests were non-lethal, with LC50s ranging from 45.1% to non-lethal.

---

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Levels of most metals, nitrogen compounds, organics and sulphate as indicated by DOC and oil and grease, are not in a range generally considered to be acutely toxic. In the case of aluminum, the levels present are probably associated with particulate since TSS is also high, and contamination from the process materials is the probable source. High TSS levels could also contribute to toxic results. If effluent toxicity at MISA Control Point CO0300 is an ongoing concern, a toxicity reduction study would be recommended to establish the source of and control measures for the toxic constituents.

Since these effluents are relatively non-toxic and only further testing could establish the source of toxicity at CO0300, BAT Option 1 is the existing system at Norton Advanced Ceramics.

### **BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), BAT and effluent limitations were not defined for the abrasives manufacturing sub-category. Furthermore, a search for "sister" abrasives plants in the U.S. found that technologies for wastewater control more advanced than those existing in Ontario were not used (Ref. 2). Thus, a BAT Option 2 was not defined.

### **BAT Option 3**

Four abrasives manufacturing plants are included in the Ontario Inorganic Chemical Sector. All plants incorporate settling and recycle of contact cooling water with discharge of overflows. Table 1 presents a comparison of major process related contaminants discharged from the four plants. Effluents from Norton compare favourably to other abrasives plants, with one exception. Aluminum levels are approximately one order of magnitude higher at Norton than elsewhere. This suggests loss of process materials to the wastewater. Despite this fact, more advanced technologies are not being used for wastewater control at any Ontario plant. For this reason, BAT Option 3 is the existing wastewater system at Norton Advanced Ceramics.

### **BAT Option 4**

Careful review of the process and quality of effluents (Tables A1 to A3) at the plant indicated that a number of contaminants including DOC, COD, nitrogen compounds, total phosphorus, boron, chromium, copper, strontium, zinc, chloride, and fluoride are present at levels which are consistent with surface water quality in Ontario. Technologies for the removal of these low levels of contaminants may be available and have been used in specific applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations.



It should also be noted that many of these contaminants are "Priority 1" parameters in the intake water, as documented in Table A5.

**Table 1**  
**Comparison of Effluents from Four Ontario Abrasives Plants <sup>1,2</sup>**

Parameter	Exolon ESK Company of Canada Ltd. <sup>3</sup>	Norton Advanced Ceramics of Canada Inc. <sup>4</sup>	Washington Mills Ltd. <sup>5</sup>	Washington Mills Electro-Minerals Corp. <sup>6</sup>
Flow (m <sup>3</sup> /d)	9,440	7,430	1,988	17,810
TSS mg/L	19	17	20	5.2
kg/d	185	123	41	94
Aluminum µg/L	280	1,433	68	159
kg/d	2.7	10.7	0.14	2.8
Oil & Grease mg/L	n.p. <sup>7</sup>	1.5	6.1	1.2
kg/d	n.p. <sup>7</sup>	11.5	12.2	20.7
Notes:  1. Average flows and loadings, and mean concentrations measured over 12 months of MISA Monitoring Regulation period. 2. Contaminant loads are not directly comparable and should be based on production rates. Production rates were unavailable for most plants. 3. Measured at Control Point CO0100 at Exolon ESK. 4. Measured at Control Point CO0200, CO0300 and CO0400 at Norton. 5. Measured at Control Point CO0100 at Washington Mills Ltd. 6. Measured at Control Point CO0100 and CO0200 at Washington Mills Electro Minerals. 7. Oil and grease not a "Priority 1" parameter at Exolon ESK.				

All three MISA Control Points (CO0200, CO0300 and CO0400) have relatively high levels of total suspended solids and aluminum. Although average levels are not extremely high, maximum levels suggest that some further control measures may be necessary. Aluminum levels are most probably associated with particulates and indicate that loss of process materials (e.g. bauxite and/or aluminum oxide product) is occurring.

The wastewater control system at Norton is somewhat unique. Contact cooling water drains to recirculation sumps prior to discharge or recycling. Wastewater therefore receives some preliminary settling in the sumps prior to formal treatment, unlike the remaining abrasives plants in Ontario.

Discharge from these sumps is then treated in settling basins prior to discharge to receiving waters. Flow data, provided by both the MISA monitoring results and company estimates, were used to confirm that these three settling basins are all operating at surface loading rates typical of primary settling units, and that no further treatment should be required since the solids should settle readily under these conditions.

An examination of the data yielded no links between high TSS levels and low flows, or other possible explanations. These excursions in TSS and aluminum suggest that cleaning of recirculation sumps may be required in addition to twice yearly cleaning of settling basins. This procedure is described in greater detail under BAT Option 4 in Section 4.1. It should be noted that the company has already increased the frequency of storm catchbasin cleanouts to twice per year in an effort to curb TSS excursions in storm water (Ref. 1).

Intake water data (Table A5) indicate high levels of TSS and this is also a likely source of TSS loadings in the effluents. The most appropriate means to control these levels would be treatment of the raw water through conventional means such as coagulation and sedimentation plus filtration. However, the problems created in the handling and disposal of treatment residuals (e.g. filter backwash) would not be offset by the relatively small improvement in effluent quality which would result. Thus, BAT Option 4 does not include measures for the reduction of TSS through intake water treatment.

Oil and grease may be contributed from the process. Because of the layout of the operations, oil leaks or spills from equipment during repairs would fall onto the floor and be washed into the settling basins with cooling water. Oil collected at the surface of the settling basins is removed by means of vacuum trucks (Ref. 1). This approach appears to be effective, since mean oil and grease levels of approximately 1 to 2 mg/L for all three effluent streams were relatively low over the 12 month monitoring period. In-plant management practices for source control are the recommended approach to further reduce oil and grease levels in effluents. These are discussed under BAT Option 4 in Section 4.1.

MISA Control Point CO0200 has three additional "Priority 1" parameters: mercury, chloroform and methylene chloride. However, it should be noted that despite the presence of these compounds, effluents at CO0200 had LC50s ranging from >100 percent to non-lethal. The source of these contaminants is not clear, although the chlorinated organics may be present in small amounts in solvents or greases used at the site. The general usage materials tables provided with the company's MISA Initial Report did not provide information on the chemical constituents of these materials. The company also reported that chlorination is not used to treat intake water. No certain source of mercury exists.

These three parameters are "Priority 1" only for CO0200, the only outfall which discharges substantial amounts of storm water in addition to process-related effluents. The other storm water outfall at the site, ST0600, also has mercury as a "Priority 1" parameter, but it was not monitored for chlorinated organics. This suggests possible mercury contamination at the site.

One sample of intake water was also tested for chlorinated organics. Although not identified as "Priority 1" parameters, chloroform was detected at 2.2 µg/L and methylene chloride was detected at 4.6 µg/L. Since these levels are comparable to

levels at CO0200, intake water cannot be ruled out as a possible source of these contaminants, even though they were not "Priority 1" parameters at the other outfalls (CO-0300 and CO0400). In addition, mercury was not a "Priority 1" parameter for intake water, but was detected at levels ranging from below the detection limit to 0.37 µg/L, again in the same range as values at CO0200.

It is also possible that detection of chloroform and methylene chloride is an analytical artifact, since these compounds are commonly used laboratory solvents.

Thus, it is recommended that a source identification and control study be undertaken in order to resolve these unanswered questions. Source control will likely be the most effective pollution prevention measure, since all three contaminants are present at levels near the limit of that achievable by available technologies for end-of-pipe treatment. As part of these efforts, a storm water management study should also be undertaken to establish whether storm water is the source of these contaminants.

Thus, BAT Option 4 consists of two recommendations:

- Regular cleaning of recirculation sumps to prevent excursions in TSS and aluminum.
- In-plant management practices for the control of oil and grease.

This option is discussed in greater detail in Section 4.1.

### **BAT Option 5**

Technologies that would advance the plant further towards zero-discharge were not identified in the global search.

The plant already recycles cooling and storm water from the recirculation sumps, to minimize the amount of intake water required and effluents discharged.

The company is considering the implementation of additional recycling by diverting flows at MISA Control Point CO0200 to the intake water pump house for complete recirculation to the process using excess intake pumping capacity. This would eliminate discharges at CO0200. The incentive for this proposal is reduction in the amount of intake water used, should intake water require chlorination/dechlorination for control of zebra mussels in the future. The company believes this option will not be limited by the temperature required for cooling. Thus, BAT Option 5 includes complete recycling of flows at CO0200.



In addition, the company is continuing to investigate the possibility of recycling effluent water from Control Points CO0300 and CO0400. At the present time, there is insufficient information available on flow rates and heat balances to assess the feasibility of these options, or associated costs. In general, the rate of recycle is dependent on the temperature required for cooling. Therefore, recycle rates tend to decrease in summer and increase in winter. Further increase in recycle rates at these outfalls would possibly require expanded equalization ponds, to allow for greater heat transfer, or more elaborate air cooled or refrigerated systems. None of these systems are considered practical due to the very large capital expenditures, and expansive land area or electricity requirements. Therefore, these approaches to cooling are not recommended for Control Points CO0300 and CO0400.

A further difficulty in implementing effluent recycle which may be encountered at Control Point CO0300 is the accumulation of alkalinity in the system and possible corrosive effects. This outfall discharges effluent from the treatment system for Alumdum<sup>R</sup>32 plant wastewater, and this water may not be suitable quality for recycle. Furthermore, study would be required to assess the feasibility of this option.

Zero-discharge of contaminants associated with contact cooling water would result if cooling water were non-contact, as would be the case if, for example, furnace cooling jackets were used. Reports from the abrasives industry (Ref. 3) indicate that this is not a feasible approach.

In aluminum oxide abrasives manufacturing, by-product ferro-silicon and other impurities collect in the bottom of the furnace. Periodically, this material is super-heated and poured out of the furnace. This procedure requires considerably more heat than for melting aluminum oxide, and results in substantial damage to the furnace refractory lining (usually bricks). The cooling method currently used, involving cascading water, is considered the only way to prevent major accidents in these instances. A water cooled jacket, for example, would be severely damaged and would not function adequately under these circumstances.

Based on the above discussion, BAT Option 5 is the complete recycle of flows at CO0200.

### Summary

Table 2 presents a summary of BAT Options defined for Norton Advanced Ceramics.

**Table 2**  
**Summary of BAT Options for Norton Advanced Ceramics**

BAT Option	Definition	Description
1	Least cost producing non-lethal effluents	<ul style="list-style-type: none"> <li>No change to existing system.</li> <li>Further toxicity testing and possible toxicity reduction study.</li> </ul>
2	U.S. BAT	<ul style="list-style-type: none"> <li>No U.S. BAT defined.</li> </ul>
3	Best demonstrated in Ontario	<ul style="list-style-type: none"> <li>No change to existing system.</li> </ul>
4	Maximum reduction of pollutants	<ul style="list-style-type: none"> <li>Regular cleaning of recirculation sumps.</li> <li>Control of oil and grease through in-plant management practices.</li> </ul>
5	Furthest towards zero-discharge of pollutants	<ul style="list-style-type: none"> <li>Same as BAT Option 4 plus complete recycle of flows at CO0200.</li> </ul>

#### 4.0 BAT OPTIONS

BAT Options 1, 2 and 3 do not incorporate changes to the existing wastewater management system at Norton Advanced Ceramics. Technologies recommended for BAT Options 4 and 5 are discussed below.

##### 4.1 BAT Option 4

##### Description

BAT Option 4 entails two aspects:

- TSS and aluminum control through regular cleanout of recirculation sumps.
- Oil and grease control through in-plant management practices.

As noted in the site visit report, some settling of solids does occur in the recirculation sumps (Ref. 1) and accumulation of solids in the sumps may be contributing to excursions in TSS and aluminum, despite twice yearly cleanout of the subsequent settling basins. Cleanout of the sumps would occur twice a year and involve recovery of solids for recycle to the furnaces wherever possible.

In-plant management practices for source control of oil and grease releases will include diligent collection of oils during equipment maintenance and repair, routine inspection of equipment for oil leaks, containment of higher risk leak and spill areas, placement of absorbent socks and pads around equipment, employee training on oil spill procedures, etc. Some of these measures are already in place at the plant, including training for clean-up of oil spills, and defined procedures for clean-up.



## Performance

The performance of the implementation of BAT Option 4 changes is presented in Table 3.

Table 3 Projected Performance of Implementing BAT Option 4					
Technology	Contaminant	Existing		Projected <sup>1</sup>	
		Mean Concentration	Average Loading	Mean Concentration	Average Loading
In-plant management practices for source control of oil and grease	Oil and grease	1.7 mg/L	12.9 kg/d	0.6 mg/L	4.8 kg/d
Cleanout of recirculation sumps twice a year	TSS	17 mg/L	123 kg/d	7.2 mg/L	53.9 kg/d
	Aluminum	1,400 µg/L	10.7 kg/d	470 µg/L	3.5 kg/d
Notes:					
1. Minimum monthly mean loading for each of three outfalls were added to obtain average loading. This figure was divided by total average yearly flow to obtain concentrations.					

The projected concentrations of all the noted contaminants are based on achieving the lowest mean monthly loadings observed over the MISA monitoring period on a consistent basis.

## Costs

Costs for implementing best management practices for oil and grease control cannot be calculated in detail, since the necessary changes to the plant and employee training could not be defined within the scope of this study. It is reasonable to assume, however, that these costs would be relatively small for minor changes around the plant such as containment implementation. Negligible costs were also assumed for including oil control procedures in staff training programs, and other routine operating requirements.

In addition, costs for the routine cleanout of recirculation sumps should be similar to those for settling basins, reported at \$2,000/basin/year (Ref. 1). There are five recirculation sumps, amounting to \$10,000/year in operating costs. No capital costs would be incurred.

## 4.2

### BAT Option 5

#### Description

BAT Option 5 consists of diverting flows from MISA Control Point CO0200 to the intake water pump house, where excess pumping capacity could be used to recycle these flows. The only capital costs associated with this option would be the piping required to make the appropriate connections.

No net increase in pumping costs would occur since less fresh water intake would be required.

#### Performance

In addition to performance that would be expected through implementation of BAT Option 4 recommendations, BAT Option 5 completely eliminates discharges at MISA Control Point CO0200, for a 100 percent reduction in loadings for that outfall.

#### Costs

MISA Control Point CO0200 is approximately 10 m from the intake water pump house. Piping, fittings and necessary modifications to the pump house itself would total approximately \$15,000 for the average flowrate of 2,700 m<sup>3</sup>/d.

## 5.0

### SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 4 presents a summary of estimated costs and projected performance of implementing BAT options at Norton Advanced Ceramics.

<b>Table 4</b>			
<b>Summary of Cost and Performance of BAT Options</b>			
<b>Component</b>	<b>BAT Options 1, 2 and 3</b>	<b>BAT Option 4</b>	<b>BAT Option 5</b>
<b>Cost</b>			
Capital	\$0	small	\$15,000
Operating	\$0	\$10,000	\$10,000
<b>Performance (Contaminant Loading Reduction)</b>			
Oil and Grease (kg/d)	0.0	8.1	>8.1
Total suspended solids (kg/d)	0.0	69.1	>69.1
Aluminum (kg/d)	0.0	7.2	>7.2

6.0

INFORMATION SOURCES

1. Inorganic Chemical Sector Plant Site Visit Report - Norton Advanced Ceramics of Canada Inc. March 21, 1991 (unpublished).
2. Telephone contacts made to U.S. abrasives manufacturing facilities by:
  - George Tasevski of Exolon-ESK in Buffalo, New York. August 1991.
  - Mark Rollins of Norton Company in Worcester, Massachusetts. August 1991.
  - Dean Venturine of Washington Mills, Niagara Falls, New York. August 1991.
3. Telephone conversation with Rick Chambers of Norton Advanced Ceramics Inc., July 1991.

## **APPENDIX**

### **Tables**





**Table A1, Norton Advanced Ceramics of Canada Inc., Chippawa Plant**  
**Summary of Flows and Priority One Pollutants**  
**MISA Control Point: CO0200**  
**Description: Combined Sewer B**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	880	3460	2700	
COD	mg/L	17	21	19	56.808
Nitrate and Nitrite	mg/L	0.4	0.4	0.4	1.205
DOC	mg/L	0.4	5.1	2.2	5.457
Total Phosphorus	mg/L	0.01	4.73	0.191	0.188
Specific Conductance	uS/cm	262	958	559	
Total Suspended Solids	mg/L	2	502	18	45.539
Aluminum	ug/L	30	880	748	2.06
Boron	ug/L	100	800	80	0.199
Strontium	ug/L	100	510	181	0.374
Zinc	ug/L	2	138	21.6	0.053
Mercury	ug/L	0.08	0.69	0.136	0
Chloroform	ug/L	0.7	5.8	3.25	0.009
Methylene Chloride	ug/L	1.9	11.4	6.65	0.019
Oil and Grease	mg/L	1	6	1.38	3.278
Chloride, Unfiltered Reactive	mg/L	17.2	18.4	17.8	53.765
Fluoride, Unfiltered Reactive	mg/L	0.14	0.31	0.225	0.697
Sulphate, Unfiltered Reactive	mg/L	30.7	39.8	35.25	107.214

**Table A2, Norton Advanced Ceramics of Canada Inc., Chippawa Plant**  
**Summary of Flows and Priority One Pollutants**  
**MISA Control Point: CO0300**  
**Description: Combined Sewer C**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	108	2890	1930	
Ammonia Plus Ammonium	mg/L	0.025	12.9	0.756	1.735
Total Kjeldahl Nitrogen	mg/L	0.07	2.45	0.976	2.106
Nitrate and Nitrite	mg/L	0.2	0.6	0.25	0.487
DOC	mg/L	0.6	6.7	2.01	3.975
Specific Conductance	uS/cm	310	1300	728	
Total Suspended Solids	mg/L	2	155	19	35.329
Aluminum	ug/L	110	840	2150	4.312
Boron	ug/L	20	80	45	0.088
Chromium	ug/L	2	90.1	14.8	0.032
Copper	ug/L	5	209	22	0.038
Strontium	ug/L	141	1670	545	1.199
Zinc	ug/L	2	217	26	0.051
Oil and Grease	mg/L	1	5	1.43	2.791
Chloride, Unfiltered Reactive	mg/L	20.6	22	21.3	53.441
Fluoride, Unfiltered Reactive	mg/L	0.2	0.21	0.205	0.51
Sulphate, Unfiltered Reactive	mg/L	24	760	239	531.047

**Table A3, Norton Advanced Ceramics of Canada Inc., Chippawa Plant****Summary of Flows and Priority One Pollutants****MISA Control Point: CO0400****Description: Combined Sewer D**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1370	4990	2800	
COD	mg/L	15	25	20	71.288
DOC	mg/L	0.8	4.8	2.1	8.154
Specific Conductance	uS/cm	200	482		
Total Suspended Solids	mg/L	2	129	13	42.452
Aluminum	ug/L	90	770	140	4.284
Copper	ug/L			13	0.052
Strontium	ug/L	100	1080	269	1.071
Zinc	ug/L	2	395	28	0.117
Oil and Grease	mg/L	1	6	1.7	6.798
Chloride, Unfiltered Reactive	mg/L	18	31.9	25	80.057
Fluoride, Unfiltered Reactive	mg/L	0.17	0.29	0.23	0.741
Sulphate, Unfiltered Reactive	mg/L	44	57.1	50.6	167.269

**Table A4**  
**Toxicity Data for Norton Advanced Ceramics for the First Six Months of**  
**MISA Monitoring Regulation**

<b>MISA Control Point</b>	<b>Test Species</b>	<b>Range of Lethal Concentration Data</b>	<b>Number of Non- Lethal Samples</b>
CO0200	Rainbow trout <u>Daphnia magna</u>	>100% to non-lethal	6 4
CO0300	Rainbow trout <u>Daphnia magna</u>	75% to non-lethal 45.1% to non-lethal	5 2
CO0400	Rainbow trout <u>Daphnia magna</u>	>100% to non-lethal >100%	3 0

**Table A5, Norton Advanced Ceramics of Canada Inc.,**

**Chippawa Plant**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN0800

Description: Intake Water, Welland River

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
Total Kjeldahl Nitrogen	mg/L	0.05	5.75	0.622
Nitrate and Nitrite	mg/L	0.2	0.6	0.239
DOC	mg/L	0.3	4.4	2.098
Total Phosphorus	mg/L	0.01	0.602	0.049
Specific Conductance	uS/cm	25	334	295
Total Suspended Solids	mg/L	2	113	10
Aluminum	ug/L	30	1520	311
Strontium	ug/L	70	630	178
Zinc	ug/L	2	493	22
Oil and Grease	mg/L	1	5	1.36
Chloride, Unfiltered Reactive	mg/L	14.7	16.1	15.4
Fluoride, Unfiltered Reactive	mg/L	0.13	0.21	0.17
Sulphate, Unfiltered Reactive	mg/L	18.2	282	27



Norton  
Niagara Falls

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS					LOADINGS				
				CO0200	CO0300	CO0400	IN0800		CO0200	CO0300	CO0400	IN0800	
c	Total suspended solids	5	mg/L	16.7	18.8	12.4	10.2		36.3	36.1	46	87.1	
c	Hydrogen Ion (pH)			7.89	7.98	8.08	7.93						
c	Specific conductance		uS/cm	367	700	330	295						
c	DOC	0.5	mg/L	2.2	2.01	2.07	2.1		5.28	3.97	8.18	18	
c	TOC	5	mg/L	3.15	2.53	2.65	2.62		6.68	4.2	8.78	22.5	
c	Oil and grease	1	mg/L	1.38	1.43	1.71	1.36		3.03	2.72	6.85	11.7	
c	Ammonia plus Ammonium	0.25	mg/L	0.035	0.756	0.067	0.029		0.171	0.207	0.883	2.05	
c	Nitrate+Nitrite	0.25	mg/L	0.4	0.25	0.25	0.239		1.21	0.483	0.883	2.05	
c	Total Kjeldahl nitrogen	0.5	mg/L	0.28	0.976	0.36	0.622		0.846	2.07	1.22	5.33	
c	Total phosphorus	0.1	mg/L	0.188	0.057	0.034	0.049		0.199	0.122	0.128	0.42	
09	Aluminum	30	ug/L	748	2150	1140	311		2.11	4.23	4.3	2.67	
09	Boron	50	ug/L	80.4	45.4	35.8	79.9		0.196	0.086	0.144	0.685	
09	Chromium	20	ug/L	11.4	14.8	13.5	11.9		0.027	0.031	0.057	0.102	
09	Copper	10	ug/L	8.3	22.1	13	8.47		0.02	0.038	0.051	0.073	
09	Strontium	20	ug/L	181	545	269	178		0.378	1.19	1.03	1.53	
09	Zinc	10	ug/L	21.6	26.5	27.9	21.9		0.056	0.05	0.118	0.188	
12	Mercury	0.1	ug/L	0.136	0.081	0.098	0.092		-	-	-	0.001	
14	Phenolics (4AAP)	2	ug/L	1	2.5	0.6	1.5		0.003	0.006	0.002	0.013	
15	Sulphide	20	ug/L	10	20	10	10		0.030	0.054	0.034	0.086	
16	1,1-Dichloroethane	0.8	ug/L	3.65	0.95	1.95	0.8		0.010	0.002	0.008	0.007	
16	1,1-Dichloroethylene	2.8	ug/L	2.45	1.2	0.9	0.8		0.007	0.003	0.003	0.007	
16	1,2-Dichlorobenzene	1.4	ug/L	1.5	0.9	0.9	4.2		0.005	0.003	0.003	0.036	
16	1,2-Dichloroethane	0.8	ug/L	1.25	0.8	0.8	0.8		0.004	0.002	0.003	0.007	
16	1,3-Dichlorobenzene	1.1	ug/L	1.5	1.1	1.1	2.3		0.005	0.003	0.004	0.020	
16	1,4-Dichlorobenzene	1.7	ug/L	1.45	1.1	1.1	1.1		0.005	0.003	0.004	0.009	
16	Chloroform	0.7	ug/L	3.25	0.8	2.25	2.2		0.009	0.002	0.008	0.019	
16	Methylene chloride	1.3	ug/L	6.65	1.6	2.7	4.6		0.019	0.004	0.010	0.039	
16	Trichlorofluoromethane	1	ug/L	1.15	1	1	1		0.004	0.003	0.004	0.009	
17	Benzene	0.5	ug/L	1.55	0.95	1.15	1.6		0.005	0.002	0.005	0.014	
17	Toluene	0.5	ug/L	1.05	0.5	2.05	2.6		0.003	0.001	0.008	0.022	
17	o-Xylene	0.5	ug/L	0.65	0.5	0.5	0.5		0.002	0.001	0.002	0.004	
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	15	1.5	1.5	1.4		0.048	0.004	0.005	0.012	
98	Flow, Average		m3/d	2560	1970	4050							
11	Chloride	2	mg/L	17.8	21.3	25	15.4		53.8	53.4	60.1	132	
12	Fluoride	0.1	mg/L	0.225	0.205	0.23	0.17		0.697	0.51	0.741	1.44	
13	Sulphate	5	mg/L	35.3	237	50.6	26.9		107	511	167	231	

Notes: CO0200, CO0300 and CO0400 are the effluents in "Sewers B,C and D" respectively. All discharge into the Welland River.

Intake loadings have been calculated from intake analyses and the sum of the effluent flows.  
These loadings values probably represent an upper bound due to rainfall contributions to the flow.

## **APPENDIX 18**

**Partek Insulations Ltd.**



# **INORGANIC CHEMICAL SECTOR PLANTS**

## **REPORT ON BAT OPTIONS**

### **PARTEK INSULATIONS LTD.**

#### **1.0 PLANT DESCRIPTION**

Partek Insulations Ltd. in Sarnia, Ontario manufactures fibre insulation in a process which melts raw materials dolomite, slag, coke and basalt rock into a molten mixture. The mixture is blown into fibres, formed and phenolic resin binder added, and then fired to cure the binder. A pipe machine forms and cuts a portion of the mineral wool to produce pipe insulation.

Intake water supplied from the City of Sarnia is used at the plant for contact cooling, washing, dust suppression of raw materials, in solutions for binding and impregnating and as once through cooling water.

Details on the plant processes and wastewater management are provided in the site visit report (Ref. 1).

#### **2.0 WASTEWATER SOURCES AND QUALITY**

##### **2.1 Sources**

Wastewater generated in the mineral wool production process, including contact cooling water, binder room and raw materials wash water, as well as storm water runoff from raw materials storage areas, are all recycled back into the process. The recycle system includes a main underground recycle sump and an outdoor collection pond, which discharges to the sump. Process wastewaters are eventually consumed in the binder and therefore, not discharged from the site.

Once through non-contact cooling water used to cool the pipe machines, discharged at a rate of 31 m<sup>3</sup>/d, was monitored at MISA Control Point OT0300 during the MISA Monitoring Regulation period. Storm water runoff from non-production areas of the site were also monitored at ST0100, ST0200 and ST0400.

##### **2.2 Wastewater Flows and Quality**

Table A1 in the Appendix presents mean, maximum and minimum flow and water quality data for those contaminants measured during the 12 months of MISA monitoring at OT0300 identified as "Priority 1" by the Ministry of the Environment.

### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed the following discussion.

#### BAT Option 1

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period, by the Ministry of the Environment for samples taken at Control Point OT0300, are presented in Appendix Table A2. Test results indicated that all effluents were lethal to rainbow trout and Daphnia magna.

---

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.



Examination of the "Priority 1" contaminants presented in Appendix Table A1, reveals no obvious source of toxicity. The likely source of toxicity is residual chlorine. Although no monitoring of total residual chlorine was carried out under the MISA program, it is reasonable to assume that residual chlorine from the municipal supply is still present at the plant intake and in the once through non-contact cooling water effluent.

Rather than implementing end-of-pipe dechlorination for the once through cooling water discharges, reuse of the once through cooling water effluent as supplemental cupola cooling water is recommended. This modification would eliminate discharges through MISA Control Point OT0300.

Therefore, BAT Option 1 entails using once through cooling water effluent to supplement cupola receiving water. The once through cooling water will required softening before it is used for cupola cooling.

### **BAT Option 2**

The U.S. Federal Register has not defined BAT applicable to mineral wool fibre manufacturing. However, glass fibre manufacturing, which incorporates similar technology with different raw materials was covered in the Federal Register 40 CFR Part 426, Subpart A Insulation Fibreglass Subcategory. BAT defined by the U.S. EPA for this category was "no discharge of process wastewater pollutants to navigable waters". Their definition of wastewater does not include non-contact cooling water or runoff. Therefore, the existing system at Partek incorporates U.S. BAT and is therefore, considered to be BAT Option 2.

### **BAT Option 3**

Partek Insulations is the only direct discharging mineral wool or glass fibre insulation producer in Ontario. Thus, BAT Option 3 is defined as the existing wastewater management system.

### **BAT Option 4**

A BAT Option 4, that demonstrates maximum pollutant reduction, was identified as the existing system. Pollutants in process waters are not added to the system, as they are recycled back into the process. Opportunities for addition of pollutants in once through cooling water operations do not exist, and this is supported by the data in Table A1. "Priority 1" contaminants in this stream are not associated with the raw materials or products at the plant, and are most likely originating in the intake water source.

Technologies for the removal of low levels of these contaminants may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

### **BAT Option 5**

Finally, a BAT Option 5 that would advance the plant furthest toward zero-discharge incorporates those technologies already existing at the plant, which result in zero discharge of process wastewaters. In addition, reuse of the once through cooling water effluent as make-up to the intake water that is softened for use in the cupola unit would eliminate discharges through MISA Control Point OT0300 as presented in the discussion of BAT Option 1.

### **Summary**

Table 1 presents a summary of BAT Options for Partek Insulations Ltd.

<b>Table 1</b> <b>Summary of BAT Options for Partek Insulations Ltd.</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluents	Reuse once through cooling water discharges to supplement intake water volume to water softener.
2	U.S. BAT	No change to existing system.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum pollutant reduction	No change to existing system.
5	Furthest toward zero discharge of pollutants	Same as BAT Option 1.

## **4.0 BAT OPTIONS**

BAT Options 2 to 4 were identified as no changes to the existing system. Option 1 and 5 are identical, and are described below.

#### 4.1 BAT Option 1 and 5

BAT Option 1 and 5 includes the existing technologies for zero-discharge of process wastewater and incorporates collection and recycle of once through cooling water. The system would involve a concrete sump for collection with alternating submersible pumps that would discharge water to the water softener influent stream to maintain the desired rate of softened water. Overflow from the sump during softener shut down (i.e. regeneration), would be directed to the recycle pit. This small volume of water is not projected to cause a significant problem in the wastewater system water balance. Figure A1 presents a flow schematic of the system.

Estimated design parameters of the system are presented in Table 2.

Operating costs of the system would be negligible. However, there would be a savings due to reduced municipal water use.

Table 2 Design Parameters for BAT Options 1 and 5 <sup>1</sup>	
Component	Description
Pumps Discharge Piping Sump	2@ 0.4 L/s 75 m @19 mm (3/4") copper piping 2 h retention time (2.3 m <sup>3</sup> )
Notes:	
1. Based on data provided in Ref. 1.	

#### Performance

If the cooling water reuse system were implemented at Partek, zero-discharge of contaminants in cooling water would be achieved. Loading reduction achievable for Priority 1 contaminants are presented in Table 3.

#### Costs

Estimated system costs were calculated from information in the Generic Technology Report for pumping stations (Ref. 2) and in-house information and are presented below:

- Sump \$10,000
- Equipment, including pumps, piping, valves and switches \$15,000

- Total (including 35% installation, 30% estimating contingency, 15% engineering and 7% G.S.T., ENR CCI<sup>2</sup> 6343). \$25,000

<b>Table 3</b> <b>Flow and Priority 1 Contaminant Loading Reduction Achievable</b> <b>With BAT Option 1 and 5</b>		
Parameter	Current Loading <sup>1</sup>	Loading With BAT Option 5
Flow	30.9 m <sup>3</sup> /d	0.0 m <sup>3</sup> /d
DOC	0.04 kg/d	0.0 kg/d
Oil and Grease	0.06 kg/d	0.0 kg/d
Sulphate	0.54 kg/d	0.0 kg/d
Notes:		
1. Based on 12 months of MISA Monitoring Regulation data at Control Point OT0300.		

Operating cost savings are estimated to be \$3,700 per year based on a municipal water cost of \$0.50 per m<sup>3</sup>.

## 5.0 SUMMARY OF BAT OPTIONS

Table 4 presents a summary of costs and performance of BAT Options recommended for Partek.

<b>Table 4</b> <b>Summary of Cost and Performance of BAT Options</b>		
Component	Estimated Result	
	BAT Options 2, 3 and 4	BAT Options 1 and 5
Cost		
• Capital	0	\$25,000
• Operating cost	0	-\$3,700 (savings)
Performance <sup>1</sup> :		
• DOC Loading	0.04 kg/d	0 kg/d
• Oil & Grease Loading	0.055 kg/d	0 kg/d
• Sulphate Loading	0.539 kg/d	0 kg/d
Notes:		
1. Total plant effluent (excluding storm water) contaminant loading for "Priority 1" pollutants, measured at MISA Control Point OT0300.		

<sup>2</sup> Engineering News Record Construction Cost Index

Storm water from contaminated site areas that is recycled into the process is currently collected in an unlined pond of native (clay) materials, without berms. Pond contents contain high fibre and phenols levels.

Although the plant has not detected groundwater or soil contamination as a result of site monitoring, the risk of environmental contamination cannot be defined. Current accepted practice for wastewater pond systems incorporate virtually impermeable pond linings, as well as berms, to protect the surrounding environment from the pond contents. Lining and provision of berms on the existing pond at Partek should be included in a comprehensive wastewater management plan for the site.

Storm water from non-process areas at the site has significant levels of TSS as well as phenolics. A Storm Water Control Study should also be undertaken at the site to establish the source of contamination and to define a program for minimizing the contaminants in storm water discharges.

1. Inorganic Chemical Sector Plants Site Visit Reports - Partek Insulations Ltd. March 19, 1991 (unpublished).
2. General Technology Report - Pumping Stations, Forcemains and Sewers.
3. General Technology Report - Pond Linings.





## **APPENDIX**

### **Tables and Figure**



**Table A1, PARTEK Insulations Ltd., Samia Plant****Summary of Flows and Priority One Pollutants****Control Point: OT0300****Description: Once through cooling water from pipe machines.**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	27.3	38	30.9	
DOC	mg/L	0.95	1.88	1.3	0.04
Specific Conductance	uS/cm	214	247	223	
Oil and Grease	mg/L	0.89	3.1	1.73	0.055
Sulphate, Unfiltered Reactive	mg/L	17.9	20.7	19.3	0.539

**Table A2**  
**Toxicity Data for Partek Insulations Ltd. (OT0300) for the First Six Months of**  
**MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow trout	2	51.1% to 77.4%	none
<u>Daphnia magna</u>	2	19.67% to 33.5%	none

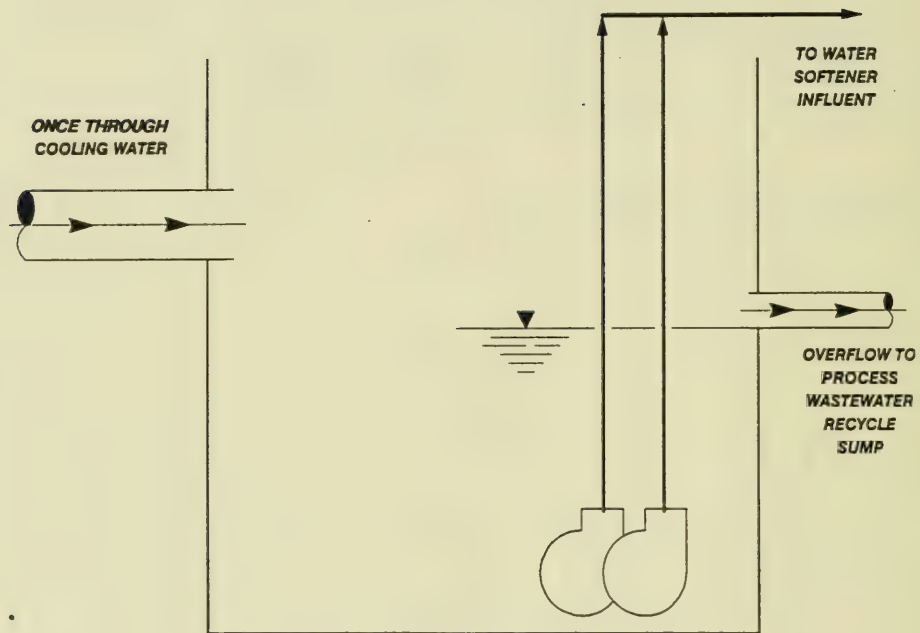


**Partek  
Samia**

ATG	PARAMETER	CONCENTRATIONS		LOADINGS kg/d	
		RMDL	UNIT	OT 0300	OT 0300
c	Total suspended solids	5	mg/L	1.08	0.034
c	Hydrogen ion (pH)			7.27	
c	Specific conductance		uS/cm	224	
c	DOC	0.5	mg/L	1.31	0.041
c	TOC	5	mg/L	72	2.02
c	Ammonia + Ammonium	0.25	mg/L		
c	Nitrate + Nitrite	0.25	mg/L		
c	Total Kjeldahl nitrogen	0.5	mg/L		
c	Oil and grease	1	mg/L	1.82	0.058
c	Total phosphorus	0.1	mg/L	0.068	0.002
98	Ftflow		m3/d	31.1	
I3	Sulphate	5	mg/L	19.3	0.541

Notes:

OT0300 is the "Cooling Water Overflow Effluent".  
This effluent eventually reaches the St. Clair River.



**Figure A1**  
**SCHEMATIC OF**  
**BAT OPTIONS 1 AND 5 FOR**  
**REUSE OF ONCE THROUGH COOLING WATER**

## **APPENDIX 19**

**Puritan Bennett**



# **INORGANIC CHEMICAL SECTOR PLANTS**

## **REPORT ON BAT OPTIONS**

### **PURITAN-BENNETT MAITLAND PLANT**

#### **1.0 PLANT DESCRIPTION**

Puritan-Bennett Maitland plant is located outside of Maitland, Ontario adjacent to the St. Lawrence River. The plant manufactures nitrous oxide for medical use as well as other applications such as automotive air bags and as a frothing agent for whipped cream.

Raw water is provided from an onsite well that was monitored under the MISA Monitoring Regulation at Control Point IN0300. Only once through non-contact cooling water and storm water are discharged from the plant site through Control Point OT0100. Other process effluents generated at the plant are pumped offsite to Nitrochem Inc. for treatment.

Details of the plant processes and wastewater management are presented in the site visit report (Ref. 1).

#### **2.0 WASTEWATER SOURCES AND QUALITY**

##### **2.1 Sources**

The sources and destination of wastewater discharges from the Puritan-Bennett plant are listed in Table 1.

All domestic wastewater is conveyed via a sanitary collector system to an onsite septic system.

Only once through non-contact cooling water is discharged directly from the Puritan-Bennett site. All process or process related wastewaters are discharged to Nitrochem Inc. for recovery and treatment.

##### **2.2 Wastewater Flows and Quality**

Appendix Table A1 presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for MISA Control Point OT0100 at Puritan-Bennett.

Table A2 presents data from the 12 month monitoring period for the intake water measured at IN0300.

**Table 1**  
**Wastewater Sources at Puritan Bennett**

Source	Type	Destination
Cooling Tower	Blowdown	Nitrochem
Reactor	Wash Water	Nitrochem
After Reactor Cooling	Condensate	Nitrochem
Floor Drains	Wash Water	Nitrochem
Purification Column	Oxalic Acid Wash Water	Nitrochem
	Second Wash Water Flush	Nitrochem
First Stage Compressor	Condensate	Nitrochem
	OTCW	Wells Creek Via Control Point OT0100
Second Stage Compressor	Condensate	Nitrochem
	OTCW	Wells Creek Via Control Point OT0100
Final Compression	OTCW	Wells Creek Via Control Point OT0100
Note:		
OTCW - Once through non-contact cooling water.		

### 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.



- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

### **BAT Option 1**

Toxicity data were not available for effluents discharged from Control Points OT0100 (cooling water discharge) at the time of report preparation. However, given the concentrations of ammonia in both the raw water and cooling water discharge, it is reasonable to believe that the raw water is contaminated and that both raw water and cooling water effluent would be potentially toxic to trout and Daphnia magna.

The simplest means of addressing the cooling water contamination would be the use of an alternative supply. Nitrochem Inc. has already established a river intake and pumping station which should be able to be adapted for Puritan-Bennett's use. However, Puritan-Bennett staff have indicated it is not feasible to employ St. Lawrence River water for cooling because of temperature requirements. Refrigeration of this raw water source may be feasible. However, information was not available at the time of report preparation to establish heat and reconfiguration requirements to evaluate the feasibility or develop a cost estimate for refrigeration of Nitrochem's water. Therefore, the alternative that must be considered is the treatment of the cooling water effluent for nitrogen removal.

Accordingly, BAT Option 1 is defined as implementation of a treatment system for ammonia reduction.

### **BAT Option 2**

Under CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition) effluent limitations were not defined for nitrous oxide facilities. Therefore, a BAT Option 2 incorporating technologies selected by the U.S. EPA for comparable facilities was not identified.

### **BAT Option 3**

Puritan-Bennett is the only producer of nitrous oxide in Ontario. Thus, BAT Option 3 was defined as the existing system in use at the Puritan-Bennett, Maitland plant.

### **BAT Option 4**

Review of the raw water and cooling water quality data shows that with the exception a small concentration of total phosphorus, all contaminants are present in the raw water and cooling water at comparable concentrations.

As already noted under BAT Option 1, the most practical means of reducing ammonia and other loadings would be the use of alternative raw water supply. However, since Puritan-Bennett has already determined that this is not feasible, biological nitrogen removal should be considered. This Option is discussed in detail in Section 4.0.

Thus, BAT Option 4 includes implementing biological nitrogen removal technologies.

### **BAT Option 5**

Technologies that would advance the plant further toward zero-discharge of pollutants were not identified in a global search. Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool process equipment in industrial gas manufacturing. Other cooling methods, such as closed loop air systems, would require very large capital expenditures and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Thus, this approach to cooling is not used in the industry.

And finally, opportunities for consumption of cooling water, condensate or wash water do not exist in the manufacture of nitrous oxide. Therefore, the recommendation for BAT Option 5 is the system as defined in BAT Option 4, since technologies that further the plant more toward zero discharge of contaminants were not identified.

### **Summary**

Table 2 presents a summary of BAT Options identified for the Puritan-Bennett, Maitland plant.

<p style="text-align: center;"><b>Table 2</b> <b>Summary of BAT Options for Puritan Bennett</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-toxic effluents.	Nitrification/denitrification of final effluent.
2	U.S. BAT.	No U.S. BAT defined.
3	Best demonstrated in Ontario.	No changes to existing system.
4	Maximum reduction of pollutants.	Nitrification/denitrification of final effluent and control oil and grease contamination at source.
5	Furthest toward zero-discharge of pollutants.	No changes to existing system.

## 4.0 BAT OPTIONS

BAT Options 2 and 3 do not incorporate changes to the existing wastewater management system at Puritan-Bennett. Technologies recommended for BAT Options 1, 4 and 5 are discussed below.

### 4.1 BAT Options 1, 4 and 5

BAT Options 1, 4 and 5 entail implementing a system to remove ammonia from the cooling water prior to discharge. A biological nitrification/denitrification reactor is the preferred technology at the ammonia concentrations presently occurring in the Puritan-Bennett effluent. A denitrification step has been included to ensure minimization of nitrate loadings.

The recommended system is comprised of biological fluidized bed reactor using pure oxygen. The system is described in detail in the General Technology Report for Biological Nitrogen Removal (Ref. 3). Table 3 presents typical system design parameters while Appendix Figure A1 presents a system schematic.

The implementation of a biological treatment system on the Puritan-Bennett property should take into consideration two additional factors. Firstly, BAT option recommendations for Nitrochem Inc. include a biological nitrogen removal system. The Nitrochem and Puritan-Bennett effluents could be consolidated and treated through a single facility. This would result in economies of scale for construction. A second factor possibly influencing the implementation of a treatment system relates to the declining ammonia concentrations in the groundwater supply. Puritan-Bennett have indicated that concentrations have declined from about 3,000 mg/L of ammonia to the current

<p align="center"><b>Table 3</b>  <b>Design Parameters for Nitrification-Denitrification Using Fluidized Bed System<sup>1</sup></b></p>		
<b>System</b>	<b>Parameter</b>	<b>Value</b>
Aerobic nitrification reactor	HRT	14 h
	SRT	70 d
	Recycle ratio	50%
	Biomass concentration	15 g VSS/L
	Typical NH <sub>3</sub> -N loading	0.01-0.03 g/g VSS/d
	Theoretical O <sub>2</sub> requirement	4.2 mg O <sub>2</sub> /mg NH <sub>3</sub> -N
Anoxic denitrification reactor	HRT	2 h
	SRT	10 d
	Recycle ratio	8:1
	Biomass concentration	25 g VSS/L
Notes:		
1. Based on pilot scale design for treating coke plant wastewaters (Ref. 3).		

50-60 mg/L during a period of about five years. Their contention is that further pumping of the groundwater supply would eventually reduce or eliminate contamination. The anticipated decline in concentration should be verified and any treatment strategy reviewed in light of the projections.

### Performance

The implementation of BAT Options 1, 4 or 5 would result in a non-lethal cooling water discharge, and a reduction in ammonia-N, and TKN as presented in Table 4.

<p align="center"><b>Table 4</b>  <b>Projected Performance of Implementing Fluidized Bed Nitrification-Denitrification System</b></p>				
Contaminant	Existing		Projected <sup>1</sup>	
	Mean Concentration (mg/L)	Average Loading (kg/d)	Mean Concentration (mg/L)	Average Loading (kg/d)
Ammonia plus ammonium (N)	58.5	8.72	< 2	< 0.3
Total kjeldahl nitrogen	61.8	9.05	< 8	< 1.2
Nitrate + Nitrite (N)	51.7	6.99	< 5	< 0.7
Notes:				
1. Ref. 3.				



## Costs

The order-of-magnitude capital cost for implementation of the system is \$1,600,000 (ENR CCI 6343<sup>2</sup>) (Ref. 3). This cost includes:

- Equipment, instrumentation and engineering for two 9.8 x 6.1 m nitrification reactors, two 2.4 x 4.3 m denitrification reactors and 7.6 m diameter clarifier with polymer system.
- Concrete reactors; oxygenator pits, pump sumps and 7.6 m diameter x 3.7 m SWD clarifier basin.
- Pumps and prefabricated pump rooms.
- Piping and valves (erected basis).
- Installation of equipment, motor control centre, power wiring, site work.
- Thirty-five percent installation, 30 percent contingency allowance, 15 percent engineering and seven percent G.S.T.

The operating costs amount to \$52,500 (\$1991), which includes the purchasing of bulk liquid oxygen, electricity, chemicals for pH adjustment, methanol requirements, and sludge disposal costs. These costs do not include the cost of labour.

## 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 5 summarizes the costs and performance of BAT Options at Puritan-Bennett.

## 6.0 INFORMATION SOURCES

1. Inorganic Chemical Sector Plants Site Visit Report - Puritan-Bennett Canada Ltd. April 25, 1991. (unpublished).
2. Twelve month MISA Monitoring Regulation data summary for Nitrochem Inc.
3. General Technology Report, Biological Nitrogen Removal.

**Table 5**  
**Summary of Cost and Performance of BAT Options**

Component	BAT Option 1	BAT Options 2, 3 and 5	BAT Option 4
Capital	\$1,600,000	0	\$1,600,000+
Operating	\$52,500	0	\$52,500+
Parameter	Performance - Approximate Loading Reduction (kg/d)		
Ammonia plus Ammonium(N)	> 8.42	0	> 8.42
Total Kjeldahl Nitrogen	> 7.85	0	> 7.85
Nitrate & Nitrite(N)	> 6.29	0	> 6.29



## **APPENDIX**

### **Tables and Figure**



**Table A1, Puritan-Bennett Canada Ltd.**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT0100

Description: Once through non-contact cooling water

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	23.6	235	221	
Ammonia plus Ammonium	mg/L	40	8	58.5	8.72
Total Kjeldahl Nitrogen	mg/L	40	86.9	61.8	9.05
Nitrate + Nitrite	mg/L	30	107	51.7	6.99
DOC	mg/L		3.5	2.54	0.395
Total Phosphorus	mg/L	0.09	0.22	0.114	0.014
Specific Conductance	uS/cm	1020	1460	1160	
Oil and Grease	mg/L	0.8	1000	183	66.1

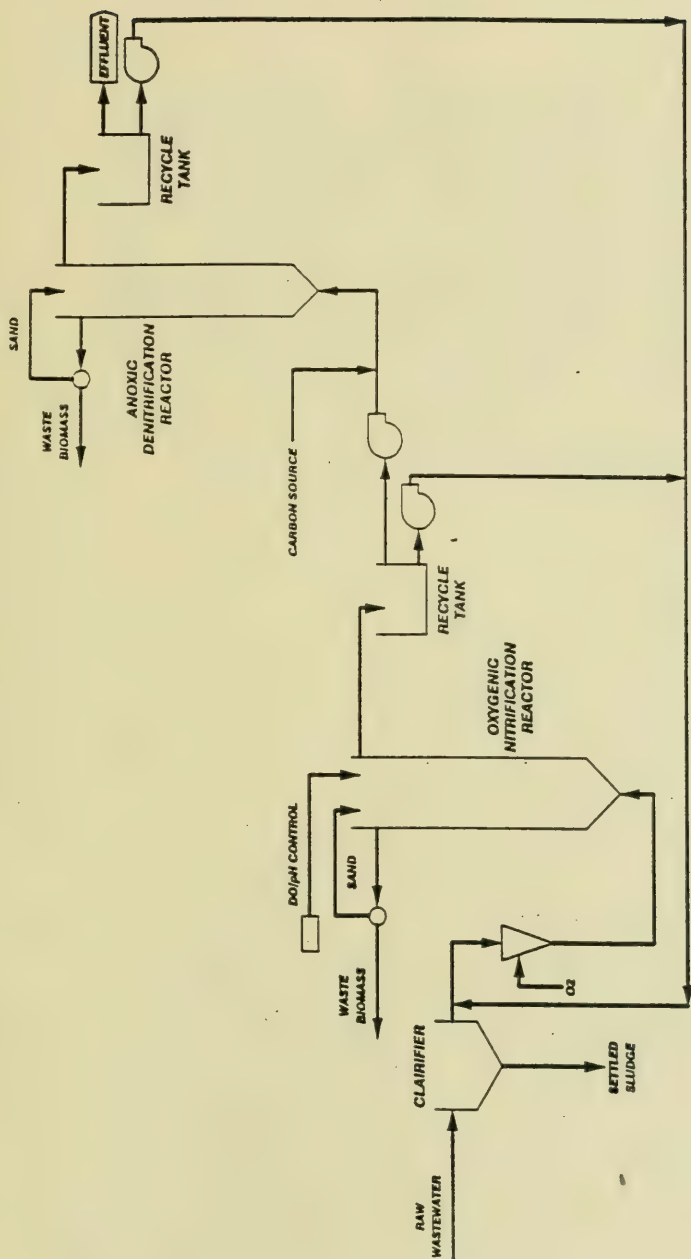
**Table A2, Puritan-Bennett Canada Ltd.**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN0300

Description: Intake water

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	255	255	255	
Ammonia plus Ammonium	mg/L	51	55	53	14
Total Kjeldahl Nitrogen	mg/L	52	55	55	14
Nitrate + Nitrite	mg/L	28.3	44	34.4	7.91
DOC	mg/L	2.49	4.89	3.56	1.25
Specific Conductance	uS/cm	1030	1150	1070	



**Figure A1**  
**TWO-STAGE FLUIDIZED BED BIOLOGICAL**  
**TREATMENT SYSTEM FOR NITROGEN REMOVAL**

**Puritan – Bennett  
Maitland**

		CONCENTRATIONS				LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	OT 0100	IN 0300	OT 0100	IN 0300
c	Total suspended solids	5	mg/L	2.66	3	0.718	0.81
c	Hydrogen ion (pH)			7.98	8.09		
c	Specific conductance		uS/cm	1160	1070		
c	DOC	0.5	mg/L	2.55	3.56	0.689	0.961
c	TOC	5	mg/L	4.4	3.4	1.19	0.918
c	Oil and grease	1	mg/L	0.945	0.95	0.255	0.257
c	Ammonia plus Ammonium	0.25	mg/L	58.5	53.3	15.8	14.4
c	Nitrate+Nitrite	0.25	mg/L	51.7	34.4	14	9.29
c	Total Kjeldahl nitrogen	0.5	mg/L	61.8	55	16.7	14.9
c	Total phosphorus	0.1	mg/L	0.114	0.093	0.031	0.025
98	Flow		m3/d	270			

Notes:

OT0100 is the "Effluent to Creek" which is discharged into the St. Lawrence River.



**APPENDIX 20**

**UCAR Carbon Canada Inc.**



# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### UCAR CARBON CANADA INC.

#### 1.0 PLANT DESCRIPTION

The UCAR Carbon Canada plant in Welland, currently produces graphite and carbon electrodes, and carbon cathode blocks.

The manufacture of graphite electrodes requires six process stages including: forming, baking, pitch impregnation, pitch bakeout, graphitizing and machining, to transform the semi-plastic mixture of calcined petroleum coke and coal tar pitch binder into crystalline graphite. The manufacture of carbon electrodes and cathodes involves; forming, baking and machining to transform the semi-plastic mixture of calcined anthracite coal and coal tar pitch binder into a homogenous amorphous mass, ready for use.

Intake water supplied by the City of Welland is used as non-contact cooling water in three cooling tower systems, and for contact cooling water in coke and coal forming. All the water supplied by the City of Welland is discharged to the sanitary sewer system. The Old Welland Canal intake water, pumped at a rate of 12,000 m<sup>3</sup>/d, is periodically shock chlorinated for zebra mussel control. Old Welland Canal water is used primarily for boiler make-up water and is also used as once through non-contact cooling water and for contact lubrication water in the diamond saw operation.

Details on the plant processes and wastewater management are provided in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Sources

All sanitary waste, cooling tower and boiler blowdown, overflow from the diamond saw recirculation/settling sump and contact cooling water used in coal and coke forming is discharged to the sanitary sewer system to be treated at the City of Welland municipal water pollution control plant. Once through non-contact cooling water from the Old Welland Canal is discharged directly.

Table 1 presents a summary of the UCAR wastewater sources and the flows in relation to the MISA Control Points.

<p align="center"><b>Table 1</b>  <b>Summary of UCAR Wastewater Sources at MISA Control Points</b></p>		
Source	MISA Control Point	Flow (m <sup>3</sup> /d)
Non-contact cooling water - Air Compressors  Storm water • Drainage from enclosed storage buildings in southwest corner of plant site	OT0100 (#2 Weir)	592
Groundwater from Baking Kilns Buildings - North side  Storm water from northern areas of plant site	CO0200 (Government Dock Weir)	20.7
Non-contact cooling water - Jar Moulding  Non-contact cooling water - Tocco Induction Heater  Non-contact cooling water - Pump Bearings  Ground water from Baking Kilns Building - South side  Storm water from western areas of the plant site	CO0300 (Pumphouse Weir)	512
Storm water from southeast areas of the plant site	ST0400 (Union Street)	1,320
Waste Disposal Site Effluent Drainage and leachate from waste disposal area	NA0500 (Waste Disposal Ditch)	6,910
Storm Water • All flow from NA0500 • Drainage from southeast areas of the plant site	ST0600 (Townline Road)	5,820

## 2.2 Wastewater Flows and Quality

Appendix Tables A1, A2, and A3 present the mean, maximum and minimum flow and water quality data for those contaminants measured during the 12 month MISA Monitoring Regulation period at OT0100, CO0200 and CO0300 respectively, which were identified as "Priority 1" pollutants by the Ministry of the Environment.

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, should be considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options is addressed in the following discussion.

#### BAT Option 1

Toxicity data collected, compiled and verified for the first six months of the MISA Monitoring Regulation period, by the Ministry of the Environment for three effluent streams are presented in Appendix Table A4. The three MISA Control Points sampled include OT0100, CO0200 and CO0300.

The OT0100 effluent was determined to be non-lethal to trout and Daphnia magna for all samples tested. All of the samples from CO0200 were non-lethal to rainbow trout, and five out of eight samples were non-lethal to Daphnia magna. The remaining three samples had lethal concentrations greater than 100 percent. The CO0300 effluent was determined to be non-lethal for all seven samples tested with Daphnia magna and for six of seven samples tested with rainbow trout. One CO0300 sample tested using rainbow trout was determined to have a lethal concentration greater than 100 percent.

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Because the effluents tested were essentially non-lethal, BAT Option 1 is defined as the existing wastewater system at UCAR.

### **BAT Option 2**

The U.S. Federal Register has not defined BAT applicable to carbon graphite manufacturing. Furthermore, facilities were not identified in the U.S. or elsewhere that could be considered as "sister" plants, with similar production lines and production capacity. Thus, BAT Option 2 was not identified.

### **BAT Option 3**

UCAR Carbon Canada Inc. is the only direct discharging carbon graphite producer in Ontario. Thus, BAT Option 3 is defined as the existing wastewater system.

### **BAT Option 4**

BAT Option 4 is intended to recommend technologies which provide maximum overall pollution control.

At both CO0200 and CO0300, the effluent is comprised of once through non-contact cooling water, groundwater from the Baking Kilns Building and storm water. At OT0100, the effluent is comprised of once through non-contact cooling water and storm water. Opportunities do not exist for the addition of contaminants to the effluent with once through non-contact cooling water operations. The possible origins of contamination at the three MISA Control Points include:

- Raw water
- Groundwater
- Storm water

Of the "Priority 1" pollutants detected at the three MISA Control Points, nitrates, fluoride, chloride, sulphate and metals are at levels typically found in surface waters. These contaminants likely originate from the raw water source or from storm water runoff.

Oil and grease, total suspended solids, and phenolics all likely originate from storm water runoff, or groundwater infiltration. If the levels of contamination are perceived to be significant, then UCAR should consider groundwater testing to determine the source of the contamination as well as implementing a Storm Water Control Study.

Technologies for the removal of low levels of contaminants present in these effluents may be available and may have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive global search carried out as part of



this study, did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 is recommended as the existing system at UCAR.

### **BAT Option 5**

BAT Option 5 incorporates technologies which will advance the plant furthest towards zero discharge. Zero discharge of process water has already been achieved by the facility. The only plant effluent is once through non-contact cooling water.

Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool process equipment in all manufacturing sectors. Other cooling methods, such as closed-loop air cooled systems, would require very large capital expenditures, hydroelectric consumption and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Thus, this approach to cooling is not used. And finally, opportunities for consumption of potential cooling tower blowdown or once through cooling water does not exist in the production of any of the "dry" products produced at UCAR. Therefore, BAT Option 5 recommendations are the same as BAT Option 4, since technologies that further the plant toward zero discharge of effluents were not identified.

### **Summary**

A summary of the BAT options identified for UCAR Carbon Canada Inc. are presented in Table 2.

<b>Table 2</b> <b>Summary of BAT Options for UCAR Carbon Canada Inc.</b> <b>Welland Plant</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluent	No change to existing system.
2	U.S. BAT	No option identified.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum overall pollution reduction	Implement Groundwater or Storm Water Control Study.
5	Furthest towards zero-discharge of pollutants	Same as BAT Option 4.

#### 4.0

#### REFERENCES

1. Inorganic Chemical Manufacturing Sector Plants Site Visit Report- UCAR Carbon Canada Inc. March 27, 1991 (unpublished).
2. U.S. Federal Register, 40 CFR Chapter 1, July 1, 1989 Edition.
3. Telephone communication with Bob Smerdon of UCAR Carbon Canada Inc. October 1991.

## **APPENDIX**

### **Tables**



**Table A1, UCAR Carbon Canada Inc., Welland**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT0100

Description: Weir #2

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	346	868	592	
DOC	mg/L	0.35	8.1	2.9	1.652
Specific Conductance	uS/cm	310	500	357	
Aluminum	ug/L	5	480	144	0.002
Copper	ug/L	5	17	9.5	0.006
Strontium	ug/L	170	290	219	0.132
Zinc	ug/L	4	270	54	0.039
Oil and Grease	mg/L	0.96	4.1	1.6	0.706

**Table A2, UCAR Carbon Canada Inc., Welland**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0200

Description: Government Dock

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1.6	56.6	20.7	
Nitrate and Nitrite	mg/L	0.08	4	0.88	0.595
DOC	mg/L	0.35	81	6.87	1.71
Total Phosphorus	mg/L	0.069	0.53	0.087	0.044
Specific Conductance	uS/cm	530	2260	1260	
Total Suspended Solids	mg/L	4	280	6.02	2.52
Aluminum	ug/L	9	200	203	0.323
Boron	ug/L	60	120	74	0.122
Strontium	ug/L	600	1600	68	1.84
Zinc	ug/L	4	240	4	0.07
Phenolics (4AAP)	ug/L	1	18	4.14	0.003
Oil and Grease	mg/L	0.96	7.6	2.03	0.879
Chloride, Unfiltered Reactive	mg/L	14	2200	179	45.1
Fluoride, Unfiltered Reactive	mg/L	0.3	0.5	0.4	0.022
Sulphate, Unfiltered Reactive	mg/L	29	1000	238	80.4



**Table A3, UCAR Carbon Canada Inc., Welland****Summary of Flows and Priority One Pollutants****MISA Control Point: CO0300****Description: Pump House Return**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0	12300	5010	
Nitrate and Nitrite	mg/L	0.34	0.46	0.4	2.88
DOC	mg/L	0.35	12	3.32	14.8
Specific Conductance	uS/cm	290	1100	554	
Aluminum	ug/L	56	170	176	0.9
Boron	ug/L	20	8	38	0.126
Copper	ug/L		20	7	0.017
Strontium	ug/L		1100	424	1.1
Zinc	ug/L	3	190	47	0.124
Phenolics (4AAP)	ug/L	1	6	2.8	0.014
Oil and Grease	mg/L	0.96	9.3	1.35	6.05
Chloride, Unfiltered Reactive	mg/L	9.7	210	25	96.5
Sulphate, Unfiltered Reactive	mg/L	18	390	64	161

**Table A4**  
**Toxicity Data for UCAR Carbon Canada Inc. for the First Six Months of the MISA**  
**Monitoring Regulation**

Description	Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-Lethal Samples
OT0100, #2 Weir effluent	Rainbow trout	2	non-lethal	2
	Daphnia magna	2		2
CO0200	Rainbow trout	8	non-lethal > 100% to non-lethal	8
	Daphnia magna	8		5
CO0300	Rainbow trout	7	> 100 % to non-lethal non-lethal	6
	Daphnia magna	7		7

Source: Six month MISA Monitoring Regulation data.

UCAR Carbon  
Welland

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS					LOADINGS			
				CO 0200	CO 0300	OT 0100	CO 0200	CO 0300	CO 0200	CO 0300	OT 0100	kg/d
c	Total suspended solids	5	mg/L	5.81	4.53	4.34		0.95	26.8			2.59
c	Hydrogen Ion (pH)			8.02	8.08	8.21						
c	Specific conductance		uS/cm	1260	370	355						
c	DOC	0.5	mg/L	7.34	3.14	2.84		0.489	18.5			1.58
c	TOC	5	mg/L	3.12	3.37	0.9		0.491	0.902			0.506
c	Oil and grease	1	mg/L	2.09	1.32	1.63		0.215	7.56			0.736
c	Ammonia plus Ammonium	0.25	mg/L	0.142	0.065			0.016	0.516			
c	Nitrate+Nitrite	0.25	mg/L	0.832	0.4			0.092	2.88			
c	Total Kjeldahl nitrogen	0.5	mg/L	0.492	0.825			0.049	7.09			
c	Total phosphorus	0.1	mg/L	0.09	0.085	0.079		0.007	0.592			0.049
09	Aluminum	30	ug/L	208	179	154		0.045	1.08			0.087
09	Boron	50	ug/L	76.7	32.7	25.3		0.007	0.145			0.015
09	Strontium	20	ug/L	1000	324	210		0.113	1.23			0.127
09	Zinc	10	ug/L	52.9	40.6	52.8		0.009	0.135			0.04
14	Phenolics (4AAP)	2	ug/L	4.58	3	1.32		0.017	0.001			
20	Phenol	2.4	ug/L	2.55	1.1							
24	Octachlorodibenzo-p-dioxin	30	pg/L	31	36.5							
98	Flow, Average		m3/d	180	6260							
98	Flow		m3/d			600						
11	Chloride	2	mg/L	151	21.3			20.2	116			
12	Fluoride	0.1	mg/L	0.4	0.1			0.022	0.749			
13	Sulphate	5	mg/L	240	52.6			38.5	192			

Notes:

CO0200 is the "Government Dock Effluent". This discharges into the Welland Canal.  
CO0300 is the "Effluent from the Pump House Return". This also discharges into the canal.  
OT0100 is the "#2 Weir Effluent" which is discharged to the canal also.



## **APPENDIX 21**

**Sulco**





# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### SULCO CHEMICALS LIMITED

#### 1.0 PLANT DESCRIPTION

Sulco Chemicals Limited manufactures sulphuric acid by the contact process. It also packages a number of acids, including:

- Hydrochloric acid
- Hydrofluoric acid
- Hydrofluorosilicic acid
- Phosphoric acid

Intake water is supplied by the Town of Elmira at a rate of approximately 200 m<sup>3</sup>/d. Water from Canagagigue Creek was also used to supplement water from the Town of Elmira from August to December 1990. Water is used for non-contact cooling, steam generation and product dilution. Boiler make-up water is pretreated by passing it through ion exchange dealkalizers and softeners. Cooling tower make-up water is treated with additives for biological, corrosion and scaling control.

Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Wastewater Sources

Wastewater sources and flows are summarized in Table 1.

Wastewater generated onsite includes boiler water treatment residuals, boiler and cooling tower blowdown, and rinse water generated in the packaging operation. These wastewaters are pH adjusted in a settling pond, followed by filtration prior to direct discharge. No process wastewater results from the sulphuric acid manufacturing process.

During the MISA effluent monitoring regulation, two Control Points were monitored, as follows:

- Control Point CO0100 - Settling basin/filtration effluent, including storm water from the south end of the plant site (sulphuric acid manufacturing, cooling tower).

- Control Point ST0200 - Storm water from the north end of the plant site (packaging, administration, storage).

These two effluent streams combine in an open ditch which discharges to the Canagagigue Creek.

<p align="center"><b>Table 1</b> <b>Wastewater Sources and Percent Flow to MISA Control Point CO0100 at Sulco Chemicals Limited</b></p>	
<b>Wastewater Source</b>	<b>Percent of Wastewater Flow</b>
Cooling Tower Blowdown (Continuous and Discontinuous)	75-80% of total
Boiler Blowdown (Continuous and Discontinuous)	20-25% of total
Boiler Water Treatment Residuals <ul style="list-style-type: none"> <li>• Sulphuric acid regenerant</li> <li>• Salt regeneration wastewater</li> </ul>	(part of 20-25%)
Packaging Effluent	<5% of total (<2 m <sup>3</sup> /week)

## 2.2 Wastewater Flows and Quality

Appendix Table A1 presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at Sulco Chemicals Limited.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

### **BAT Option 1**

Toxicity data were collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment. These data are presented in Appendix Table A2.

Seven rainbow trout tests and seven Daphnia magna tests were carried out on samples taken from CO0100. Six of the seven rainbow trout samples were non-lethal. One of the samples had a lethal concentration greater than 100 percent. The lethal concentrations of the seven samples tested with Daphnia magna ranged from 70 percent to non-lethal, with 5 non-lethal samples.

Because the majority of the samples tested were non-lethal to the test species, and the remaining samples were only slightly lethal to the test species, the recommended BAT Option 1 is the existing wastewater management system at Sulco.

### **BAT Option 2**

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition), subpart U for Sulphuric Acid Production subcategory, BAT was not defined. No effort was given to developing BPT, BAT, NSPS or a pretreatment regulation for the sulphuric acid subcategory since monitoring results indicated that the small quantities of toxic pollutants found during screening were well below levels considered as treatable (Ref. 2).

The recommended BAT Option 2 is the existing wastewater management system at Sulco.

### BAT Option 3

Two Ontario plants included in the Ontario Inorganic Chemical Sector were categorized as packaging plants, Sulco Chemicals Limited and Conpak.

A comparison of the operating features of the two facilities is presented in Table 2. Although Sulco produces sulphuric acid, no effluent from this process is discharged. Conpak does not appear to be directly comparable to the operations at Sulco since over 95 percent of the wastewater flows at Sulco do not originate from packaging operations, and the only products packaged at Sulco are inorganic acids. The Sulco wastewater treatment system consists of sodium carbonate addition followed by settling ponds, and cloth bag filtration. The system operates on a continuous basis and the effluent is monitored for pH. When pH excursions occur, alarms are activated and the sodium carbonate dosage rates are adjusted accordingly. In comparison, at Conpak, the only wastewater treatment involves batch pH adjustment prior to discharge.

<p align="center"><b>Table 2</b> <b>A Comparison of the Operating Features at Conpak and Sulco Chemicals Ltd.</b></p>		
<b>Parameter</b>	<b>Conpak</b>	<b>Sulco Chemicals Limited</b>
Intake water source	City of Cornwall	Town of Elmira
Effluent flow (m <sup>3</sup> /d)	33	68
Products manufactured	None	Sulphuric acid
Products packaged	<ul style="list-style-type: none"> <li>Sulphuric acid</li> <li>Hydrochloric acid</li> <li>Hydrogen peroxide</li> <li>Caustic potash</li> <li>Sodium hypochlorite</li> <li>Caustic soda</li> <li>Ammonium hydroxide</li> <li>Nitric acid</li> <li>Acetic acid</li> <li>Hydrofluorosilicic acid</li> <li>Chlorine</li> <li>Sulphur dioxide</li> <li>Anhydrous ammonia</li> </ul>	<ul style="list-style-type: none"> <li>Hydrochloric acid</li> <li>Hydrofluoric acid</li> <li>Hydrofluorosilicic acid</li> <li>Phosphoric acid</li> <li>Sulphuric acid</li> </ul>
Wastewater treatment	<ul style="list-style-type: none"> <li>Two neutralization/check tanks in series.</li> <li>pH controlled using hydrochloric acid and caustic soda addition.</li> <li>No mixing.</li> <li>Batch discharge approximately 8 times each day.</li> </ul>	<ul style="list-style-type: none"> <li>pH adjustment by soda ash addition.</li> <li>Settling in primary and secondary pond.</li> <li>Secondary pond effluent cloth filtered.</li> <li>Sludge removal in pond system.</li> </ul>
Sources of wastewater	<ul style="list-style-type: none"> <li>Mixing vessel wash water.</li> <li>Hydrostatic testing water.</li> <li>Spent scrubber liquor.</li> <li>Floor drain wastewater.</li> </ul>	<ul style="list-style-type: none"> <li>Cooling tower blowdown (75 to 80%).</li> <li>Boiler blowdown and water softener regeneration water 20 to 25%.</li> <li>Neutralized packaging washwater effluent (&lt;5%).</li> </ul>



A comparison of the effluent quality for a few selected "Priority 1" pollutants is presented in Table 3. As expected, from the contrast in activities at the two facilities, the levels of some of the parameters are very different at the two plants.

These comparisons suggest, that Sulco is the only plant of its kind, in the Ontario Inorganic Chemical Sector. Therefore, the recommended BAT Option 3 is the existing system at Sulco.

**Table 3**  
**Comparison of Effluent Concentrations and Loadings at Two Acid Packaging Facilities in the Ontario Inorganic Chemical Sector**

Parameter	Facility			
	Conpak		Sulco Chemicals Limited	
	Concentration (mg/L)	Daily Loading (kg/d)	Concentration (mg/L)	Daily Loading (kg/d)
TKN	37	1.18	0.85	0.06
Nitrate/Nitrite	57	1.84	9.7	0.68
Total Phosphorus	6.6	0.252	0.66	0.046
TSS	83	3.2	14.4	0.76
Oil and Grease	2.88	0.099	2.26	0.157
Chloride	1,360	49.3	1,830	123
Fluoride	1.94	0.044	4.07	0.278
Sulphate	986	35.7	1,640	114

#### **BAT Option 4**

BAT Option 4 is intended to provide maximum overall pollution control. The only process water discharged includes neutralized wash water generated by the rinsing of carboys and drums for refilling with product acids. Other sources of wastewater include:

- Effluent from the regeneration of the dealkalizer and softener units.
- Boiler blowdown.
- Cooling tower blowdown.
- Storm water runoff.

Examination of the mean concentration of total suspended solids (TSS) in the final effluent as reported in Appendix Table A1, (14.4 mg/L) suggests that improved solids removal could be considered, since consistent levels of 5 mg/L are achievable with coagulation/settling/filtration systems (Ref. 3 and 4). A detailed examination of the

MISA Monitoring Regulation data revealed that a significant TSS excursion (1,510 mg/L) occurred during October 1990, following a plant shut down period. As well, significant TSS excursions (ranging from 14 to 51 mg/L) occur as a result of storm events (Ref. 5). Due to the fluctuations in the TSS effluent levels, recommendations for improved TSS removal are included in BAT Option 4.

The mean zinc level in the effluent (1,590 µg/L) is significant. Sulco has indicated that these escalated values were the result of corrosion of the sample containers, and do not reflect the concentration of zinc in their effluent (Ref. 5). Early in the sampling program, sample containers had galvanized steel lids. Contact of the sample, which is acidified for preservation, with the lid would result in dissolution of zinc. Examination of the monthly MISA Monitoring Regulation data confirms that after March 1990 (when the sampling procedures were altered), there was a significant decrease in the concentration of zinc in the final effluent from an average of 4,200 µg/L (December, 1989 to March, 1990) to 420 µg/L (April 1990 to November, 1990). To further reduce zinc loadings, Sulco reports that during the MISA Monitoring Regulation period, a zinc/phosphate based water conditioning additive was exchanged with a phosphate-based additive.

The remaining zinc in the effluent, averaging 420 µg/L from April to November 1990, should be removed, to some extent, with improved TSS removal, as recommended above. However, this removal may be enhanced by ensuring that soda ash addition in the primary settling basin raises pH to the 8.0 to 8.5 range. This minimizes zinc solubility (without exceeding allowable pH levels for discharge) and will increase the amount of zinc available for removal by settling. Thus improved settling and pH adjustment are recommended for zinc removal under BAT Option 4 at Sulco.

Although this measure will achieve only partial removal of zinc (see Section 4.1) further measures cannot be recommended until the remaining sources of zinc are identified. Thus, zinc should be included in a Source Identification and Control Study. Further reduction or elimination of zinc will most likely be based on source controls such as process changes, materials substitution, storm water management or best management practices.

The mean strontium concentration (6,640 µg/L) is likely the result of strontium in the raw water being concentrated by cooling tower and boiler operation. There is no specific process source for this contaminant.

Vanadium is a component of the catalyst used in the manufacture of sulphuric acid. The maximum concentration of vanadium occurred during shut down. Since there is no direct contact of plant effluent with this catalyst, and the maximum level was achieved during a time when maintenance on the reaction unit was in progress, the likely source of the vanadium is storm water. Thus, reduction or elimination of vanadium in the effluent will be based on source controls such as catalyst substitution, or storm water management.



The oil and grease levels (2.26 mg/L) and the phenolics levels (3.6 µg/L) could be reduced using an oil absorption column as presented in the General Technology Report (Ref. 10). Alternatively, pollution control activities such as in-plant management practices could be exercised in the plant site.

A likely source of sulphide (124 µg/L) is fugitive emissions from the burning of sulphur in the production of sulphuric acid and the resulting storm water runoff. Reduction or elimination of sulphide in the effluent will be based on source controls through process changes, such as improved air emission quality, or through storm water management.

The source of total phosphorus in the effluent (0.66 mg/L) is likely the water treatment chemicals. However, since this level is low, and alternative water conditioning chemicals will likely introduce other contaminants (Ref. 7) replacement of the water treatment chemicals for total phosphorus reduction is not recommended.

The levels of chloride (1,830 mg/L), fluoride (4.0 mg/L), and sulphate (1,640 mg/L) are significant in the effluent. The most likely sources of these contaminants are the washing of the acid containers, the deionization regeneration effluent, and boiler blowdown. The technologies to treat these levels of chloride, fluoride and sulphate include:

- Preconcentration of the waste stream using reverse osmosis, ion exchange or electrodialysis. Flow rates of residuals requiring further treatment will total approximately 10 to 30 percent of the original flow.
- Further concentration of the waste stream through evaporative technologies such as vapour compression evaporation or steam-driven evaporation.
- Crystallization of the concentrated waste stream through the use of spray dryers or equivalent technologies.
- Disposal of resulting solid wastes.

Preconcentration technologies require careful control of operating conditions to avoid fouling or deterioration of membranes or resins and may require additional pretreatment steps such as removal of solids and/or organics. All of these technologies are both energy and labour intensive. Further description of these technologies, as well as further information on capital and operating costs, are included in a separate report. These added operational and technological complexities are not likely to be offset by the improvement in wastewater quality at Sulco. Thus, recommendations for BAT Option 4 do not include measures for the control of dissolved solids such as chlorides, fluorides and sulphates.

"Priority 1" contaminants with no specific process source include cyanide and arsenic. Careful review of the processes, raw materials, products and chemicals used at the

plant within the scope of this study did not reveal a source of these contaminants. An audit of the possible sources of these contaminants is necessary through a Source Identification and Control Study<sup>2</sup>. Reduction or elimination of these contaminants in discharges will most likely be based on source controls such as process changes, materials substitution, storm water management or in-plant management practices.

However, it should be noted that arsenic levels are well below the Provincial Water Quality Objective of 100 µg/L and that technologies for removal of such low levels from industrial wastewaters were not identified in exhaustive global search. Technologies for the removal of cyanide include alkaline chlorination. However, this technology is not normally applied to low levels of total cyanide such as these. In addition this treatment step would require subsequent dechlorination of effluent to ensure non-lethality. This added operational complexity would not likely be offset by the improvement in water quality which would result at Sulco. Therefore, measures to reduce arsenic and cyanide loadings have not been included under BAT Option 4.

A review of remaining contaminants detected in the final effluent indicates that most are not generated in the process and may be the result of raw water contaminants concentrated by cooling tower and boiler operation. These contaminants include; ammonia plus ammonium, nitrates and TKN, and metals. Technologies for the removal of low levels of contaminants present in the plant effluents, may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies for treating industrial wastewater effluents with similar contaminant concentrations. Thus, recommendations for BAT Option 4 do not include technologies for removal of these contaminants.

In summary, recommendations for BAT Option 4 include:

- Improved TSS removal and pH adjustment.
- A Source Identification and Control Study for zinc cyanide and arsenic.
- Oil and grease, and phenol control.

These measures are discussed in detail in Section 4.0.

## **BAT Option 5**

Technologies that would advance the plant further toward zero-discharge were not identified in a global search. Cooling water provided by once through non-contact and

---

<sup>2</sup>

Source Identification and Control Study involves an audit of the possible sources of this contaminant. Reduction or elimination of this contaminant in the final effluent may be source controls through process changes, materials substitution, improved air emission quality, best management practices, or through storm water management.

recirculation cooling tower systems are invariably used to cool process equipment in industrial manufacturing. Other cooling methods, such closed-loop air cooled systems, would require very large capital expenditures, operating costs (for electricity) and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Thus, this approach to cooling is not used. And finally, opportunities for consumption of cooling tower blowdown, boiler blowdown, regeneration effluent, or wash water do not exist in the production of sulphuric acid. Therefore, the recommended BAT Option 5 that includes technologies which advance the plant furthest towards zero discharge of pollutants is the same as BAT Option 4.

## **Summary**

Table 4 presents a summary of BAT Options for Sulco Chemicals Limited.

<b>Table 4</b> <b>Summary of BAT Options for Sulco Chemicals Limited</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluent	• No change to existing system.
2	U.S. BAT	• No change to existing system.
3	Best demonstrated in Ontario	• No change to existing system.
4	Maximum overall pollution reduction	• Improved TSS Removal. • A Source Identification and Control Study for cyanide and arsenic.
5	Furthest towards zero-discharge of pollutants	• Same as BAT Option 4.

## **4.0 BAT OPTIONS**

The recommendations for BAT Options 1, 2, and 3 were no changes to the existing system. BAT Option 4 and 5 are described below.

### **4.1 BAT Option 4 and 5**

#### **Description**

BAT Options 4 and 5 entails the following:

- TSS removal and pH adjustment system consisting of chemical mixing and a sedimentation basin.

- A Source Identification and Control Study for zinc, cyanide and arsenic.
- Oil and grease and phenol control through best management practices.

Currently, the wastewater generated from container washing is neutralized in a sump prior to discharge to the centralized treatment area. The centralized treatment involves sodium carbonate addition to the primary settling basin, which overflows to the secondary settling basin. The effluent from the secondary settling basin is treated using cloth bag filtration prior to final discharge. The wastewater streams discharging directly to the primary settling basin include cooling tower blowdown, packaging operation effluent combined with storm water, storm sewer flows from the south central area of the site, backwashes from boiler water treatment, and continuous boiler blowdown. Discharges to the secondary settling basin include discontinuous boiler blowdown, effluents from the cloth filter cleaning operation, storm sewer flows from the southeast corner of the plant, and floor drainage from the maintenance building.

Sedimentation tank performance is related to several related factors (Ref. 6) including:

- Surface hydraulic loading rate.
- Hydraulic retention time.
- Solid loading rate.
- Depth.
- Length/width ratio for rectangular basins.

In Table 5, typical settling basin design data are compared to existing settling basins at Sulco Chemicals Limited. A review of these data suggest that the depth of the settling basins at Sulco are not sufficient to provide for adequate settling of the total suspended solids.

All discharges to the centralized wastewater treatment system should be directed to the primary settling basin to receive chemical treatment, so that the primary settling basin is functioning as a chemical mixing zone. Soda ash should be added to attain a pH of from 8.0 to 8.5 to maximize the precipitation of zinc without exceeding pH discharge limits.

The only source of wastewater to the secondary settling basin should be the overflow from the primary settling basin. The secondary settling basin should then be deepened to allow for adequate clarification. The recommended modifications include increasing the depth of the secondary settling basin to 2 m, and building berms around the perimeter of the basin so the effective depth is 3 m. The basin will be clay-lined and the berms will be covered with rip-rap and geotextile to prevent erosion.



**Table 5**  
**Comparison of Typical Settling Basin Design Parameters to the Settling Basin Characteristics at Sulco**

Parameter	Typical Range of Values	Values at Sulco <sup>2</sup>
Hydraulic loading rate (m <sup>3</sup> /m <sup>2</sup> /d)	20 to 65	0.35
Hydraulic retention time (hr)	1.5 to 3	3.6 to 17 <sup>3</sup>
Depth (m)	3 to 4.5 m	0.10 to 0.25
Rectangular basin length to width ratio	>4	3
Notes:		
1.	Ref. 6.	
2.	Determined using data from MISA Monitoring Regulation period, and information collected during MISA site visit (Ref. 1).	
3.	Depth may vary from 0.10 m to 0.25 m.	

A secondary settling basin with adequate depth as recommended above will help to dampen the effects of solids loadings resulting from storm events and similar upsets. This should result in more reliable operation of the subsequent filter and reduce the frequency and severity of loading resulting from filter breakthrough. The frequency of filter bag changing will also be reduced.

One further operational improvement may contribute to reducing suspended solids loadings due to excursions. It is likely that TSS excursions occur whenever the filter cloth is newly installed and before an adequate filtercake has formed. It is recommended that effluent during these periods be directed to the primary settling basin rather than being discharged. This will not significantly increase the surface loading rate the secondary settling basin.

The Source Identification and Control Study for zinc, cyanide and arsenic was described in Section 3.

Best management practices for source control of oil and grease and phenols will include diligent collection of oils during equipment maintenance and repair, routine inspection of equipment for oils leaks, containment of higher risk leak and spill areas, placement of absorbent socks and pads around equipment, employee training on oil spill procedures, etc.

## Performance

The projected performance of implementing BAT Options 4 and 5 is presented in Table 6. A combined settling and filtration system should be capable of producing an effluent with 5 mg/L of TSS (Ref. 4). In addition, zinc should be reduced to approximately 200 µg/L if properly settled and filtered after pH adjustment to 8.0 to 8.5. This estimate is based on the solubility of zinc in this pH range. The projected concentrations of the oil and grease and phenols are based on achieving the lowest mean monthly loadings observed over the MISA Monitoring Regulation period on a consistent basis.

**Table 6**  
**Projected Performance of Implementing BAT Options 4 and 5**

Technology	Contaminant	Existing <sup>1</sup>		Projected	
		Concentration	Loading (kg/d)	Concentration	Loading (kg/d)
Improved settling and filtration with pH adjustment.	TSS	14.4 mg/L <sub>2</sub>	0.762	5.0 <sup>3</sup> mg/L	0.265
	Zinc	420 µg/L <sup>2</sup>	$2.86 \times 10^{-2}$	200 µg/L	$1.36 \times 10^{-2}$
Best management practices for oil and grease.	Oil and Grease	2.26 mg/L	0.157	1.08 mg/L <sup>4</sup>	0.074
	Phenolics	3.6 µg/L	$2.45 \times 10^{-4}$	1.22 µg/L <sup>4</sup>	$8.3 \times 10^{-5}$
Notes:					
1. See Table A1.					
2. Mean concentration for April to November, 1990 only. Loadings calculated using mean concentration and average flow.					
3. Ref. 4.					
4. Lowest monthly mean concentration during MISA Monitoring Regulation.					

## Costs

The estimated capital costs for modifying the settling system (\$33,700) are presented in Table 7. Labour costs associated with operation of the filter will be reduced, since the frequency of filter bag changing will be reduced (the frequency of filter bag changing can not be predicted without TSS influent data). However, chemical addition costs may increase in order to attain the desired pH of from 8.0 to 8.5. It is not possible to estimate these costs without further information on the alkalinity of the wastewater or treatability studies.

The implementation of a Source Identification and Control Study for zinc, cyanide and arsenic would cost approximately \$25,000 (\$1991).

Costs for implementing best management practices for oil and grease control cannot be calculated in detail, since the necessary changes to the plant and employee training



could not be defined within the scope of this study. It is reasonable to assume, however, that these costs would be relatively small for minor changes around the plant such as containment implementation. Negligible costs were also assumed for oil control procedures in staff training programs, and other routine operating requirements.

**Table 7**  
**Capital Cost for Modification of Existing Settling System<sup>1</sup>**

Item	Capital Cost
<b>Primary Settling Modifications</b>	
• Includes installation of transfer pipes from discharge locations to secondary settling	\$3,300
<b>Secondary Settling Modifications</b>	
• Includes berms, clay lining, excavation, rip-rap, geotextile	\$30,400
<b>Total</b>	<b>\$33,700</b>
Notes:	
1. All costs include:	
• 30% installation	
• 35% estimating contingency	
• 15% engineering and	
• 7% GST (on total) (ENR CCI 6343)	

Thus, the total capital cost for implementing BAT Options 4 and 5 is approximately \$58,700 (\$1991), which does not include costs for implementing best management practices for oil and grease.

## **5.0 SUMMARY OF BAT OPTIONS**

Table 8 presents a summary of costs and performance of the BAT Options recommended for Sulco.

## **6.0 REFERENCES**

1. Inorganic Chemical Sector Plants, Site Visit Report, Sulco Chemicals Ltd. March 19, 1991 (unpublished).
2. U.S. EPA, 1980. *Development Document for Effluent Limitations Guidelines and Standards for the Inorganic Chemicals Manufacturing Point Source Category*, EAA/1-79/007.
3. General Technology Report, Sedimentation for TSS Removal.

<b>Table 8</b> <b>Summary of Cost and Performance of BAT Options for Sulco</b>		
Component	Estimated Result	
	BAT Options 1, 2, and 3	BAT Options 4 and 5
Cost		
Capital <sup>1</sup>	0	\$58,700
Operating (\$1991)	0	Unknown <sup>2</sup>
Performance (Contaminant loading reduction, kg/d)	No change	
• TSS		0.497
• Zinc		$1.5 \times 10^{-2}$
• Oil and grease		0.083
• Phenolics		$1.62 \times 10^{-4}$
Notes:		
1. Based on ENR CCI 6343.		
2. Dependent on TSS levels to settling basins, and settling basin performance.		

4. Sister Plant Technology Report - Coagulation/Sedimentation/Filtration Ponds at Cabot Canada Ltd.
5. Koniuch, Ron. Sulco Chemicals Limited. Telephone conversation. November 1991.
6. Treatability Manual Volume III - Technologies for Control/Removal of Pollutants, EPA-600/2-82-001c. September 1981.
7. General Technology Report, Water Conditioning Chemicals for Cooling Tower and Boiler Make-up.

## **APPENDIX**

### **Tables**



**Table A1, Sulco Chemicals Limited, Elmira**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: Final Effluent

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	0	129	68.1	
COD	mg/L	31	100	66	4.833
Cyanide Total	mg/L	0.005	0.127	0.03	0.002
Ammonia Plus Ammonium	mg/L	0.05	0.97	0.257	0.021
Total Kjeldahl Nitrogen	mg/L	0.3	2.4	0.854	0.06
Nitrate and Nitrite	mg/L	2.08	28.6	9.7	0.679
DOC	mg/L	0.5	15.2	5	0.356
TOC	mg/L	5	11	7.8	0.546
Total Phosphorus	mg/L	0.2	1.62	0.66	0.046
Specific Conductance	uS/cm	744	16700	7500	
Total Suspended Solids	mg/L	3.6	92	14.4	0.762
Aluminum	ug/L	50	92	240	0.017
Boron	ug/L	1	500	173	0.013
*Cadmium	ug/L	1	14	5.2	0.000354
Cobalt	ug/L	2	40	16.5	0.001
Copper	ug/L	20	140	37	0.003
Nickel	ug/L	2	90	38	0.003
Lead	ug/L	10	112	34	0.003
Strontium	ug/L	3000	12000	6640	0.483
Vanadium	ug/L	3	792	53	0.004
Zinc	ug/L	33	36000	1590	0.11
*Arsenic	ug/L	1.8	12	5.5	0.000375
*Phenolics (4AAP)	ug/L	0.8	47	3.6	0.000245
Sulphide	ug/L	15	110	24	0.002
Oil and Grease	mg/L	0.23	8.1	2.26	0.157
Chloride, Unfiltered Reactive	mg/L	282	4760	1830	123.044
Fluoride, Unfiltered Reactive	mg/L	0.012	27.3	4.07	0.278
Sulphate, Unfiltered Reactive	mg/L	676	7890	1640	114.401

Note: \* These loadings were determined using the mean flow and concentration data.

**Table A2**  
**Toxicity Data for Sulco Chemicals Limited for the First Six Months of MISA**  
**Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow trout	7	>100% to non-lethal	6
<u>Daphnia magna</u>	7	70% to non-lethal	5



**Sulco Chemicals**  
**Elmira**

		CONCENTRATIONS		LOADS kg/d
ATG	PARAMETER	RMDL	UNIT	CO 0100
c	Total suspended solids	5	mg/L	14.8
c	Hydrogen ion (pH)			7.63
c	Specific conductance		uS/cm	7570
c	DOC	0.5	mg/L	4.97
c	TOC	5	mg/L	7.83
c	Oil and grease	1	mg/L	2.26
c	Ammonia plus Ammonium	0.25	mg/L	0.257
c	Nitrate + Nitrite	0.25	mg/L	9.73
c	Total Kjeldahl nitrogen	0.5	mg/L	0.854
c	Total phosphorus	0.1	mg/L	0.664
09	Aluminum	30	ug/L	240
09	Boron	50	ug/L	173
09	Cadmium	2	ug/L	5.16
09	Cobalt	20	ug/L	16.5
09	Copper	10	ug/L	37
09	Lead	30	ug/L	33.9
09	Nickel	20	ug/L	38.1
09	Strontium	20	ug/L	6650
09	Vanadium	30	ug/L	53.2
09	Zinc	10	ug/L	1590
10	Arsenic	5	ug/L	5.5
12	Mercury	0.1	ug/L	0.07
14	Phenolics (4AAP)	2	ug/L	3.57
15	Sulphide	20	ug/L	23.9
16	Chloroform	0.7	ug/L	2.97
19	Benzylbutylphthalate	0.6	ug/L	0.4
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	1.25
2	Cyanide Total	0.005	mg/L	0.03
98	Ftflow		m3/d	68.1
I1	Chloride	2	mg/L	1830
I2	Fluoride	0.1	mg/L	4.07
I3	Sulphate	5	mg/L	1640

**Notes:**

CO0100 is the "Final Effluent". This is discharged into Canagagigue Creek.  
This creek joins the Grand River.



## **APPENDIX 22**

**Union Carbide Linde, Morre**



**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
LINDE (DIVISION OF UNION CARBIDE CANADA LIMITED)  
MOORE TOWNSHIP SITE**

**1.0      PLANT DESCRIPTION**

Nitrogen gas is produced at the Linde-Union Carbide plant in Moore Township by extraction from air using a compression and distillation process, with the remaining gaseous components being vented to the atmosphere. Gaseous nitrogen is compressed for on-site storage and is also transferred by pipeline to nearby customers. Intake water from the Sarnia (Lambton County) municipal water supply is used at the plant as cooling tower make-up. Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

**2.0      WASTEWATER SOURCES AND QUALITY**

**2.1      Wastewater Sources**

Plant sanitary wastewater and spills from within the process building are not discharged directly. They are directed to a sanitary sewer, which leads to an on-site weeping tile system. All other wastewater sources discharge to a single storm sewer which was monitored as part of the MISA Monitoring Regulation program at Control Point CO0100. The effluent is discharged to the Concession Road No. 8 ditch, which eventually discharges to the St. Clair River.

The only process wastewater generated in the production of nitrogen gas is air compressor condensate, at a rate of 2.7 m<sup>3</sup>/d. This wastewater is not discharged, but is reused in the plant to reduce the volume of cooling tower make-up water required. Cooling tower blowdown passes through a sump which allows for some settling to occur, and then mixes with storm water prior to discharge through MISA Control Point CO0100.

During the MISA Regulation Monitoring period, the average discharge rate through Control Point CO0100 was 12 m<sup>3</sup>/d.

**2.2      Wastewater Flows and Quality**

Table A1 in the Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at Linde, Moore Township Site.

### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

#### BAT Option 1

Toxicity data were collected, compiled and verified for the first six months of the MISA Regulation Monitoring period by the Ministry of the Environment. Three rainbow trout tests and four Daphnia magna tests were carried out on samples taken at Control Point CO0100. All of the samples were non-lethal. Thus, the existing wastewater management system was considered as BAT Option 1.

---

1 Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.



## **BAT Option 2**

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition), subpart AW for the Oxygen and Nitrogen Production Subcategory, BAT was not defined. However, limitations for oil and grease and pH based on the best practicable control technology (BPT) currently available were defined for this subcategory. These recommendations are presented in Table 1 and are compared to actual data for the Moore Township site, based on MISA Regulation monitoring results.

**Table 1**  
**U.S. EPA BPT Limits Compared to Data from Linde, Moore Township Plant**

Parameter	BPT Effluent Limits <sup>1</sup>		Actual Values	
	Maximum for 1 day	Average of Daily Values for 30 Consecutive Days	Maximum for 1 day <sup>2</sup>	Average Yearly Value <sup>3</sup>
Oil and Grease (kg/tonne of product)	0.0020	0.0010	0.0018	0.00035
pH	6.0 to 9.0	6.0 to 9.0	6.2 to 9.0	8.2 <sup>4</sup>
Notes:				
1. Ref. 3.				
2. Based upon the maximum concentration and the average flow.				
3. Range of daily values for 30 consecutive days was not available.				
4. Values presented are for first six months of MISA monitoring. Data for 12 months of monitoring was not finalized				

The values calculated for final oil and grease loadings at the Moore plant show that these were well below the BPT limits on average, and did not exceed the maximum limit. Furthermore, pH limits were met. Thus, the existing system at the Linde-Moore plant represents U.S. BPT, and was considered as BAT Option 2.

## **BAT Option 3**

Five Ontario gas plants included in the Ontario Inorganic Chemical Sector were examined as part of this study. Table 2 presents a comparison of main operating features in the five plants. Both cooling towers and once through cooling water systems are used, in addition to gravity oil/water separation of compressor condensates. Although systems vary slightly from plant to plant, in general, all of these plants have equivalent technologies for wastewater management, and no one plant could be considered as representing the best in use in the Province. Thus, BAT Option 3 was defined as the existing system at the Linde-Moore plant.

#### **BAT Option 4**

Through an assessment of the process, it is understood that effluent from the plant will contain contaminants as a result of cooling tower operations, and also those present in

<b>Table 2</b> <b>Comparison of Operating Features at Five Ontario Gas Plants</b>	
<b>Plant</b>	<b>Operating Feature</b>
Linde (Division of Union Carbide Canada Ltd.) - Moore Township	<ul style="list-style-type: none"><li>• Cooling tower used.</li><li>• Water treatment chemicals include:<ul style="list-style-type: none"><li>- Dearborn 735</li><li>- Dearborn Poly-E1-PH905</li></ul></li><li>• Municipal water source.</li></ul>
Linde (Division of Union Carbide Canada Ltd.) - Sarnia	<ul style="list-style-type: none"><li>• Cooling tower used.</li><li>• Water treatment chemicals include:<ul style="list-style-type: none"><li>- Dearborn 735</li><li>- Dearborn Poly-E1-PH905</li><li>- Bird-Archer 3057</li></ul></li><li>• Municipal water source.</li></ul>
Linde (Division of Union Carbide Canada Ltd.) - Sault Ste. Marie	<ul style="list-style-type: none"><li>• Cooling tower used.</li><li>• Water treatment chemicals include:<ul style="list-style-type: none"><li>- Dearborn 546</li><li>- Dearborn 726</li><li>- Dearborn Poly-E1-PH905</li><li>- Dearborn 747</li></ul></li><li>• Cooling tower blowdown solids are concentrated in a cyclone separator prior to discharge.</li><li>• Water source- Lake Superior.</li></ul>
Liquid Carbonic Inc. - Courtright	<ul style="list-style-type: none"><li>• Once through non-contact cooling water.</li><li>• Water source- ICI Nitrogen Products, Lambton Works</li></ul>
Liquid Carbonic Inc. - Maitland	<ul style="list-style-type: none"><li>• Both once through and cooling tower non-contact cooling water is used.</li><li>• Water treatment chemicals:<ul style="list-style-type: none"><li>- Betz C63P (bromine)</li><li>- Betz MS-120</li><li>- Betz J-12</li><li>- Betz 35106</li><li>- Betz K-1-2</li></ul></li><li>• Water source- onsite well.</li></ul>

compressor condensate, since this makes up a portion of the blowdown. Cooling tower operations contribute contaminants through the addition of water treatment chemicals, and as a result of corrosion of system materials. At the Moore plant, the copper levels are not excessive, and there is insufficient data to indicate whether their primary source is a result

of corrosion or from intake water. Because there is no obvious indication of corrosion, (i.e. high copper levels) copper removal is not addressed in BAT Option 4.

Phosphate based chemicals added to treat cooling tower make-up water to prevent corrosion of the system are likely the primary source of phosphorus in plant effluents. Bromination of cooling tower make-up water for bacterial control is the likely cause of bromoform in effluents. These chemicals are necessary to the operation of the cooling tower, and produce an effluent that is non-toxic. Ozonation was identified as an alternative to chemical addition in a global search for alternatives to reduce or eliminate the chemical levels in effluents. This process is however, still in the developmental stages (Ref. 7) and therefore, cannot be recommended for implementation.

Compressor condensates have been shown to contain oil and grease in varying amounts, depending on the type, maintenance and age of the compressor. One source of oil and grease present in the plant effluent is the compressor condensate used as cooling tower make-up water, although an undetermined amount may also be contributed from the stormwater or raw water. Oil and grease levels in plant effluents are very low, and their primary source is unknown. Thus, BAT Option 4 does not include reduction of oil and grease levels in effluents.

A review of contaminants detected in plant effluents indicates that most of these are not generated in the process, but are likely present in the raw water and concentrated in the cooling tower as a result of evaporation, and precipitated, due to the alkaline nature of the operation. These contaminants include; TSS including metal precipitates, nitrates and TKN, chloride, fluoride, sulphate, and oil and grease.

Technologies for the removal of low levels of contaminants present in Linde, Moore effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

Furthermore, an undetermined portion of contaminants such as TSS may be present in the effluents through MISA Control Point CO0100 from stormwater runoff, which is mixed with the settled cooling tower blowdown stream before monitoring. General technologies for improved TSS removal include improved settling and precipitation with chemical addition and are presented in a general technology report (Ref. 4). In addition, low levels of oil and grease may be removed from plant effluents using an oil absorption column, presented in a general technology report (Ref. 5).

In the consideration of the BAT options, all of the contaminants identified as Priority 1 by the MOE were not addressed (i.e. methylene chloride). Careful review of the processes, raw materials, products and chemicals used at the plant within the scope of this study did not reveal a source of this contaminant. Thus, an audit of the methylene chloride is necessary, and reduction or elimination of this contaminant in discharges will be based on source

controls through process changes, materials substitution, or best management practices.

### BAT Option 5

Technologies that would advance the plant further toward zero-discharge were not identified in a global search. Cooling water provided by once through or recirculating cooling tower systems are invariably used to cool process equipment in industrial gas manufacturing. Other cooling methods, such closed-loop air cooled systems, would require very large capital expenditures and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Furthermore, opportunities for consumption of cooling tower blowdown or condensate do not exist in the production of nitrogen gas. Therefore, BAT Option 5 is the existing wastewater management system, since technologies that further the plant toward zero discharge of effluents were not identified.

### Summary

Table 3 presents a summary of BAT Options for the Union Carbide, Linde Moore Township plant.

Table 3 Summary of BAT Options for Union Carbide-Linde Moore Township Plant		
BAT Option	Definition	Description
1	Least cost producing non-lethal effluent	No change to existing system.
2	U.S. BAT	No change to existing system.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum overall pollution reduction	No change to existing system.
5	Furthest towards zero-discharge of contaminants	No change to existing system.

## 4.0

### REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report- Linde (Division of Union Carbide Canada Limited), Moore Township Plant. March 20, 1991 (unpublished).
2. U.S. EPA, 1980. *Development Document for Effluent Limitations Guidelines and Standards for the Inorganic Chemicals Manufacturing Point Source Category*, EPA 440/1-79/007.
3. U.S. Federal Register, 40 CFR Chapter 1, July 1, 1989 Edition.
4. General Technology Report, TSS Removal by Settling.



5. General Technology Report, Oil and Grease Removal by Absorption.
6. Telephone and telefax communication, with Bob Irwin of Dearborn Chemical Co. Ltd. Mississauga, Ontario. September 1989.
7. Telephone and telefax communication, with Randy Fletcher of Linde - Union Carbide, Tonawanda, New York. July/Aug/Sept 1991.





## **APPENDIX**

### **Figures and Tables**



**Table A1, Union Carbide Canada Ltd., Linde-Moore TWP.**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: Combined - Final Effluent

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m <sup>3</sup> /d	10.7	233	12	
COD	mg/L	40	100	70	0.749
Hydrogen Ion (pH)		6.2	838	11	
Total Kjeldahl Nitrogen	mg/L	2.3	2.87	2.58	0.028
Nitrate and Nitrite	mg/L	10.4	12.4	11.4	0.122
DOC	mg/L	2.5	14.8	9.55	0.148
TOC	mg/L	4	17.3	11.6	0.181
Total Phosphorus	mg/L	0.16	1.77	0.802	0.014
Specific Conductance	uS/cm	414	890	894	
Total Suspended Solids	mg/L	1	9	9	0.11
Aluminum	ug/L	40	660	304	0.006
Boron	ug/L	20	2780	812	0.011
Chromium	ug/L	20	70	27	0.001
Copper	ug/L	10	60	44	0.001
Zinc	ug/L	10	250	114	0.006
Arsenic	ug/L	16	17	16.5	0.0002
Bromoform	ug/L	17	26	21.5	0.0003
Methylene Chloride	ug/L	3.5	9	6.25	0.00008
Oil and Grease	mg/L	1	14.4	2.6	0.033
Chloride, Unfiltered Reactive	mg/L	65.7	81	73.4	0.785
Fluoride, Unfiltered Reactive	mg/L	0.8	4.9	2.85	0.03
Sulphate, Unfiltered Reactive	mg/L	90	120	105	1.123

**Table A2**  
**Toxicity Data for Linde (Division of Union Carbide Canada Limited)**  
**Moore Township Site for the First Six Months of MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow trout	3	all non-lethal	3
<u>Daphnia magna</u>	4	all non-lethal	4

Linde  
Moore

		CONCENTRATIONS		LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	CO 0100	CO 0100
c	Total suspended solids	5	mg/L	8.78	0.107
c	Hydrogen ion (pH)			8.29	
c	Specific conductance		uS/cm	899	
c	DOC	0.5	mg/L	9.84	0.148
c	TOC	5	mg/L	11.8	0.179
c	Oil and grease	1	mg/L	2.48	0.032
c	Ammonia plus Ammonium	0.25	mg/L	0.07	0.001
c	Nitrate + Nitrite	0.25	mg/L	11.4	0.122
c	Total Kjeldahl nitrogen	0.5	mg/L	2.59	0.028
c	Total phosphorus	0.1	mg/L	0.923	0.014
09	Aluminum	30	ug/L	303	0.006
09	Boron	50	ug/L	746	0.01
09	Chromium	20	ug/L	26.7	0.001
09	Copper	10	ug/L	45.8	0.001
09	Strontium	20	ug/L	549	0.015
09	Zinc	10	ug/L	121	0.006
10	Antimony	5	ug/L	3	—
10	Arsenic	5	ug/L	16.5	—
16	Bromoform	3.7	ug/L	21.5	—
16	Methylene chloride	1.3	ug/L	6.25	—
17	Toluene	0.5	ug/L	0.43	—
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	3.45	—
24	Octachlorodibenzo-p-dioxin	30	pg/L	56	—
24	Octachlorodibenzofuran	30	pg/L	75	—
24	Total H7CDD	30	pg/L	34.5	—
2	Cyanide Total	0.005	mg/L	0.012	—
98	Ftflow		m3/d	12.1	
11	Chloride	2	mg/L	73.4	0.785
12	Fluoride	0.1	mg/L	2.85	0.03
13	Sulphate	5	mg/L	105	1.124

Notes:

CO0100 is the "Final Effluent" stream which discharges into the St.Clair River.

Flow values were estimated due to fitting of an incorrectly oversized device.  
Flow and loading values therefore should be treated with caution.





## **APPENDIX 23**

**Union Carbide Linde, Sarnia**



**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
LINDE (DIVISION OF UNION CARBIDE CANADA LIMITED)  
SARNIA SITE**

**1.0      PLANT DESCRIPTION**

Nitrogen gas is produced at the Linde-Union Carbide plant in Sarnia by extraction from air using a compression and distillation process. The remaining gaseous components are vented to the atmosphere. Gaseous nitrogen is compressed for on-site storage and is also transferred by pipeline to nearby customers. There are three separate production units at the plant site. Intake water from the Sarnia (Lambton County) municipal water supply is used at the plant as cooling tower make-up. Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

**2.0      WASTEWATER SOURCES AND QUALITY**

**2.1      Wastewater Sources**

Plant sanitary wastewater, compressor condensate from 2 of the 3 production units and spills from within all process buildings are directed to a sanitary sewer, which leads to the Sarnia municipal wastewater treatment facility. All other wastewater sources discharge to a single storm sewer which was monitored as part of the MISA Regulation Monitoring Program at Control Point CO0100. The effluent is then discharged to the Cole Drain, which eventually discharges to the St. Clair River. All of the wastewater sources contributing to CO0100 are presented in Table 1.

<b>Table 1 Sources of Effluent to Storm Sewer</b>	
<b>Description of Source</b>	<b>Estimated Flow (m<sup>3</sup>/d)</b>
Plant #2 air compressor condensate	2.7
Blowdown from Plants #1, #2, and #4 cooling towers	46.6
Storm water runoff	not available
Roof runoff	not available
Steam heater condensate, three sources in Plant #2	1.0
Steam condensate from the nitrogen vaporizing pit	12.5
<b>Total (12 month average over MISA Monitoring period)</b>	<b>173</b>

The only process wastewater generated in the production of nitrogen gas is air compressor condensate at an estimated rate of 2.7 m<sup>3</sup>/d. This wastewater is mixed with cooling tower blowdown, storm water runoff, roof runoff, steam heater condensate, and the steam condensate from the nitrogen vaporizing pit prior to discharge through CO0100. The only wastewater stream that receives treatment prior to discharge is the cooling tower blowdown which passes through a sump allowing for some settling to occur. It is then combined with storm water, steam heater condensate, roof runoff and steam condensate prior to discharge through MISA Control Point CO0100.

During the MISA Regulation Monitoring period, the average discharge rate through Control Point CO0100 was 173 m<sup>3</sup>/d.

## 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at Linde, Sarnia Site.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.

1

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

### **BAT Option 1**

Toxicity data were collected, compiled and verified for the first six months of the MISA Regulation Monitoring period by the Ministry of the Environment. These data are presented in Table A2. Four rainbow trout tests and four Daphnia magna tests were carried out on samples taken at Control Point CO0100. The toxicity of the trout samples ranged from 80.6 percent to non-lethal with only one non-lethal sample. None of the Daphnia magna tests were non-lethal. The Daphnia magna test results ranged from 43.1 percent to greater than 100 percent.

A review of the "Priority 1" pollutants presented in Table A1 reveals no obvious toxicity source. Thus, Linde-Sarnia should consider implementing a Toxicity Reduction Study.

In order to produce a non-toxic effluent, several tasks should be considered within the scope of a Toxicity Reduction Study, including:

- Confirm the toxicity of the effluent.
- Enumerate potential toxic contaminants.
- Identify sources of potential toxic contaminants.
- Identify alternatives to eliminate toxic contaminants.
- Develop a toxicity reduction management program.
- Implement a toxicity reduction management program.

One possible source of toxicity which should be investigated in the Toxicity Reduction Study is the bromination of cooling water. Residual bromine was not considered in the MISA Regulation Monitoring. The possibility therefore exists that bromine or brominated compounds contribute to toxicity. If the Toxicity Reduction Study confirms this possibility, then an alternative biocide should be considered (Ref. 7).

Since BAT Option 1 is dependent upon the outcome of the Toxicity Reduction Study, no recommendations concerning the application of pollution control technology can be made at this time.

## **BAT Option 2**

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition), subpart AW for the Oxygen and Nitrogen Production Subcategory, BAT was not defined. However, limitations for oil and grease and pH based on the best practicable control technology (BPT) currently available were defined for this subcategory. These BPT recommendations are presented in Table 2, where they are compared to actual data for the Sarnia site, based on MISA Regulation monitoring results.

The values calculated for final oil and grease loadings at the Sarnia plant show that these slightly exceed the BPT limits on average, and exceeded the maximum daily limit. On average the pH limits were met; however the maximum pH recorded over the 12 month MISA monitoring period slightly exceeded the range of acceptable BPT pH values. Thus, the Linde-Sarnia plant is close to compliance with the U.S. EPA BPT for average values. However, the frequency of excursions above the maximum daily limit should be investigated. If excursions occur frequently, the source of the oil and grease should be identified and controlled.

**Table 2**  
**U.S. EPA BPT Limits Compared to Data from Linde, Sarnia Plant**

Parameter	BPT Effluent Limits <sup>1</sup>		Actual Values	
	Maximum for 1 day	Average of Daily Values for 30 Consecutive Days	Maximum for 1 day <sup>2</sup>	Average Yearly Value <sup>3</sup>
Oil and Grease (kg/tonne of product)	0.0020	0.0010	0.0058	0.0011
pH	6.0 to 9.0	6.0 to 9.0	6.2 to 9.1 <sup>4</sup>	7.7
Notes:				
1. (Ref. 3).				
2. Based upon the maximum concentration and the average flow.				
3. Range of daily values for 30 consecutive days was not available.				
4. The maximum and the minimum daily pHs are presented here, since the pH limit is a range of values.				

During the MISA site visit, oil was being discharged from one of the process buildings to the ground (Ref. 1). As well, according to staff at Linde-Sarnia, Cole Ditch overflows periodically flooding the Sarnia site with water which may become contaminated with surface deposited oils (Ref. 6). Based on these observations, storm water runoff is a potential source of oils and may contribute to the excursions above the maximum daily limits as noted above. Stormwater pollution prevention measures should be considered to reduce the amount of oil and grease.

Compressor condensates also contain oil and grease in varying amounts, depending on the type, maintenance and age of the compressor. Although compressor condensate does discharge to MISA Control Point CO0100, the compressor condensate is treated



using a gravity oil/water separator prior to mixing with the cooling tower blowdown and storm water.

BAT Option 2 is defined as the existing system at the Linde-Sarnia plant which, when coupled with stormwater control, should consistently meet U.S. BPT.

### **BAT Option 3**

Five Ontario gas plants included in the Ontario Inorganic Chemical Sector were examined as part of this study. Each plant had some unique operating features which are presented in Table 3. Examination of these features reveals no obvious best technology. Since no one plant could be considered as representing the best wastewater system in the Province, BAT Option 3 is defined as the existing system at the Linde-Sarnia plant.

### **BAT Option 4**

BAT Option 4 is intended to provide maximum overall pollution control. All contaminants resulting from plant operations are theoretically controllable. The possible sources of pollution originating from plant operations in the effluent include steam condensate, compressor condensate and cooling tower blowdown. Since the steam is non-contact, the steam condensate should theoretically be distilled water. As mentioned earlier, the compressor condensate may be a minor source of oil and grease but already has appropriate control technology in place. Cooling tower operations contribute contaminants through the addition of water treatment chemicals, as a result of corrosion of system materials and through the concentrating effect achieved during its operation.

During the MISA monitoring period, Bird-Archer 3057™, a zinc/phosphate buffered water treatment chemical was used. This particular water treatment chemical could be replaced but would, no doubt, introduce other contaminants to the effluent. The average zinc concentration of 9.5 µg/L and the mean concentration of phosphorus of 1.03 mg/L were low, and hence replacement of the water treatment chemicals is not recommended.

At the Linde-Sarnia plant, there are insufficient data to determine if the primary source of the copper is a result of corrosion or due to the concentrating effect of the cooling tower. Copper levels were not excessive (125 µg/L) and hence copper removal was not considered for BAT Option 4.

A review of remaining contaminants detected in the final effluent indicates that most are not generated in the process and may be the result of raw water contaminants concentrated by cooling tower operation. These contaminants include TSS including metal precipitates, nitrates and TKN, chloride, fluoride and sulphate.

<p align="center"><b>Table 3</b> <b>Comparison of Operating Features at Five Ontario Gas Plants</b></p>	
<b>Plant</b>	<b>Operating Feature</b>
Linde (Division of Union Carbide Canada Ltd.) - Moore Township	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include: <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sarnia	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include: <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Bird-Archer 3057</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sault Ste. Marie	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include: <ul style="list-style-type: none"> <li>- Dearborn 546</li> <li>- Dearborn 726</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Dearborn 747</li> </ul> </li> <li>• Cooling tower blowdown solids are concentrated in a cyclone separator prior to discharge.</li> <li>• Water source- Lake Superior.</li> </ul>
Liquid Carbonic Inc. - Courtright	<ul style="list-style-type: none"> <li>• Once through non-contact cooling water.</li> <li>• Water source- ICI Nitrogen Products, Lambton Works</li> </ul>
Liquid Carbonic Inc. - Maitland	<ul style="list-style-type: none"> <li>• Both once through and cooling tower non-contact cooling water is used.</li> <li>• Water treatment chemicals: <ul style="list-style-type: none"> <li>- Betz C63P (bromine)</li> <li>- Betz MS-120</li> <li>- Betz J-12</li> <li>- Betz 35106</li> <li>- Betz K-1-2</li> </ul> </li> <li>• Water source- onsite well.</li> </ul>

Technologies for the removal of low levels of contaminants present in the plant effluents, may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treat industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

Priority 1 contaminants with no specific process source include total heptachlorodiben-zodioxin (H7CDD), and octochlorodibenzo-p-dioxin. Careful review of the processes, raw materials, products and chemicals used at the plant within the scope of this study did not reveal a source of these contaminants. One possible source of these contaminants suggested by Linde, Sarnia is stormwater. An audit of the possible sources of these contaminants is necessary, and reduction or elimination of these contaminants in discharges may be based on source controls such as process changes, materials substitution, storm water management or best management practices.

### **BAT Option 5**

Technologies that would advance the plant further toward zero-discharge of contaminants were not identified in a global search. Cooling water provided by once through non-contact and recirculation cooling tower systems is invariably used to cool process equipment in industrial gas manufacturing. Other cooling methods, such closed-loops air cooled systems, would require very large capital expenditures, operating costs (for electricity) and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Furthermore, opportunities for consumption of cooling tower blowdown or condensate do not exist in the production of nitrogen gas. Therefore, a BAT Option 5 that includes technologies which advance the plant furthest towards zero discharge was defined as the existing system at Linde, Sarnia.

### **Summary**

Table 4 presents a summary of BAT Options for the Union Carbide, Linde Sarnia plant.

<b>Table 4</b> <b>Summary of BAT Options for Union Carbide-Linde</b> <b>Sarnia Plant</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluent	Develop using the outcome of the Toxicity Reduction Study.
2	U.S. BAT	No change to existing system. Recommend storm water management and practices program.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum overall pollution reduction	No change to existing system.
5	Furthest towards zero-discharge of contaminants	No change to existing system.

#### 4.0

#### REFERENCES

1. Inorganic Chemical Sector Plants Site Visit Report- Linde (Division of Union Carbide Canada Limited), Sarnia Plant. March 21, 1991 (unpublished).
2. U.S. EPA, 1980. *Development Document for Effluent Limitations Guidelines and Standards for the Inorganic Chemicals Manufacturing Point Source Category*, EAA440/1-79/007.
3. U.S. Federal Register, 40 CFR Chapter 1, July 1, 1989 Edition.
4. Telephone and telefax communication with Bob Irwin of Dearborn Chemical Co. Ltd. Mississauga, Ontario, September 1989.
5. Telephone and telefax communication with Randy Fletcher of Linde - Union Carbide, Tonawanda, New York, July/Aug/Sept 1991.
6. Telephone and telefax communication with Enzo Marrella of Linde - Union Carbide, Sarnia, March/Oct 1991.
7. General Technology Report, Water Treatment Chemicals for Boiler and Cooling Tower Make-up.

## **APPENDIX**

### **Tables**





Table A1, Union Carbide Canada Ltd., Samia.  
Summary of Flows and Priority One Pollutants  
MISA Control Point: CO0100  
Description: Combined - To Cole Dr.

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	65.5	13800	173	
COD	mg/L	40	110	75	4.93
Hydrogen Ion (pH)		6.2	9.1	7.7	
Ammonia Plus Ammonium	mg/L	0.28	0.33	0.305	0.02
Total Kjeldahl Nitrogen	mg/L	3.88	3.95	3.92	0.258
Nitrate and Nitrite	mg/L	3.49	3.9	3.7	0.244
DOC	mg/L	2.7	18.9	10.7	0.893
TOC	mg/L	4.2	30.4	13.1	1.17
Total Phosphorus	mg/L	0.29	3.72	1.03	0.096
Specific Conductance	uS/cm	379	1840	873	
Total Suspended Solids	mg/L	1	98	11	7.4
Aluminum	ug/L	20	1340	368	0.034
Boron	ug/L	20	3290	930	0.079
Copper	ug/L	40	340	125	0.01
Strontium	ug/L	350	650	496	0.038
Zinc	ug/L	160	930	445	0.034
Arsenic	ug/L	7	12	9.5	0.001
*Total H7CDD	pg/L	67	170	118	2.02E-08
*Octochlorodibenzo-p-dioxin	pg/L	580	590	585	1.01E-07
Oil and Grease	mg/L	1	13.4	2.6	0.246
Chloride, Unfiltered Reactive	mg/L	61	71.9	66.4	4.38
Fluoride, Unfiltered Reactive	mg/L	0.6	3	1.8	0.118
Sulphate, Unfiltered Reactive	mg/L	100	140	120	7.91

Note: \* These loadings were determined using the mean flow and concentration data.

**Table A2**  
**Toxicity Data for Linde-Sarnia Plant Site**  
**for the First Six Months of MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow trout	4	80.6 %- non-lethal	1
<u>Daphnia magna</u>	4	43.1 % to >100%	none

Linde  
Samia

		CONCENTRATION		LOADINGS kg/d
ATG	PARAMETER	RMDL	UNIT	CO 0100
c	Total suspended solids	5	mg/L	10.5
c	Hydrogen ion (pH)			7.77
c	Specific conductance		uS/cm	876
c	DOC	0.5	mg/L	10.6
c	TOC	5	mg/L	12.9
c	Oil and grease	1	mg/L	2.51
c	Ammonia plus Ammonium	0.25	mg/L	0.305
c	Nitrate + Nitrite	0.25	mg/L	3.7
c	Total Kjeldahl nitrogen	0.5	mg/L	3.92
c	Total phosphorus	0.1	mg/L	1.06
09	Aluminum	30	ug/L	281
09	Boron	50	ug/L	854
09	Copper	10	ug/L	134
09	Strontium	20	ug/L	489
09	Zinc	10	ug/L	454
10	Antimony	5	ug/L	4.5
10	Arsenic	5	ug/L	9.5
14	Phenolics (4AAP)	2	ug/L	2.5
16	1,1-Dichloroethane	0.8	ug/L	0.8
16	Bromoform	3.7	ug/L	8
16	Chloroform	0.7	ug/L	0.65
16	Methylene chloride	1.3	ug/L	6.6
17	Toluene	0.5	ug/L	0.38
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	3.5
24	Octachlorodibenzo-p-dioxin	30	pg/L	585
24	Octachlorodibenzofuran	30	pg/L	54.5
24	Total H6CDD	30	pg/L	31
24	Total H6CDF	20	pg/L	24.5
24	Total H7CDD	30	pg/L	119
24	Total H7CDF	30	pg/L	38
98	Ftflow		m3/d	164
11	Chloride	2	mg/L	66.5
12	Fluoride	0.1	mg/L	1.8
13	Sulphate	5	mg/L	120

Notes:

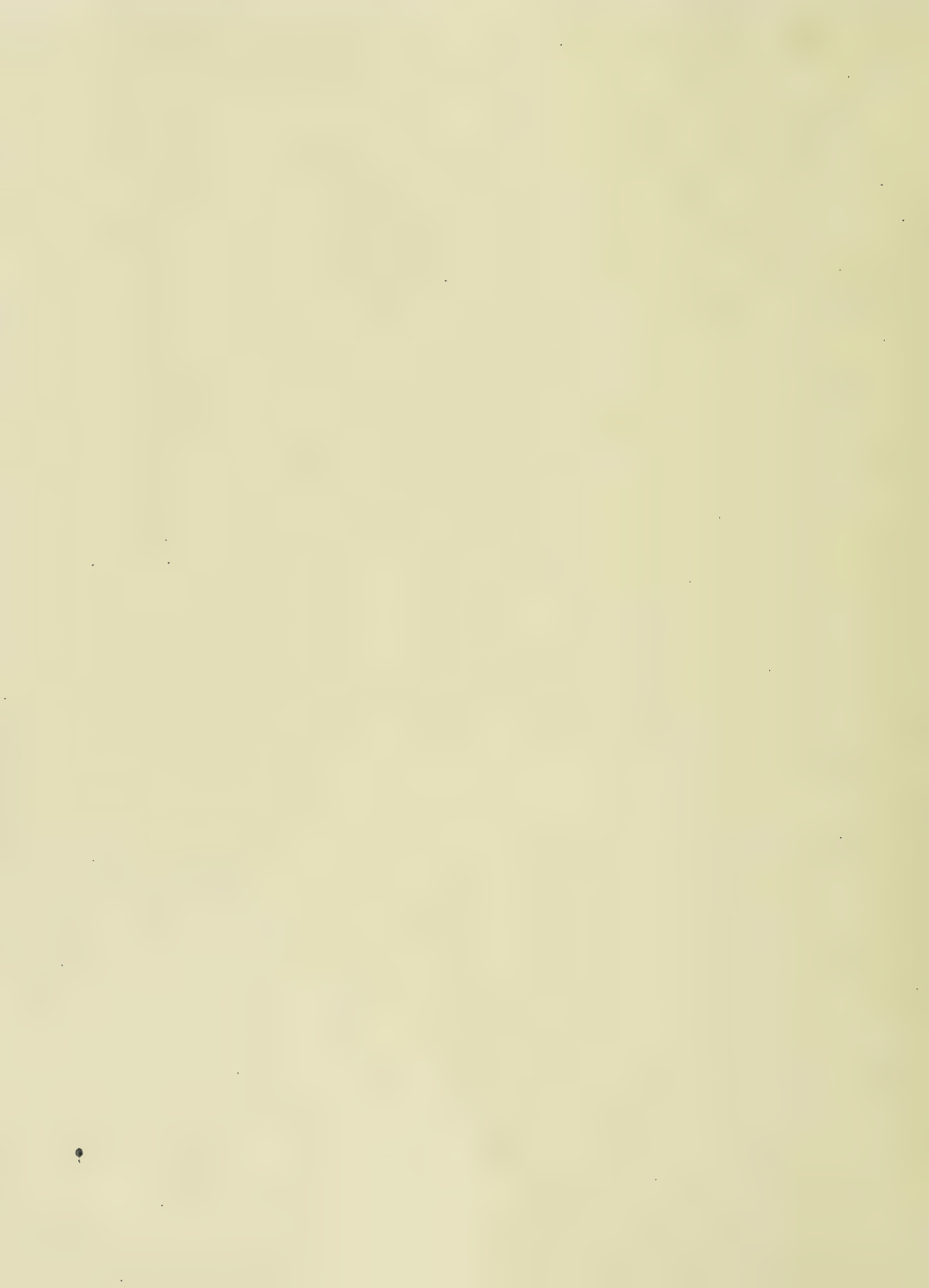
CO0100 is the "Effluent to Cole Drain from Cooling Towers".  
The Cole Drain discharges into the St. Clair River.

Flow readings were estimated due to the fitting of an oversized device.  
Flow and loading values therefore should be treated with caution.



## **APPENDIX 24**

**Union Carbide Linde, Sault Ste. Marie**





**ONTARIO INORGANIC CHEMICAL SECTOR PLANTS  
REPORT ON BAT OPTIONS  
LINDE (DIVISION OF UNION CARBIDE CANADA LIMITED)  
SAULT STE. MARIE SITE**

**1.0      PLANT DESCRIPTION**

Nitrogen, oxygen and argon gases are produced at the Linde-Union Carbide plant in Sault Ste. Marie by extraction from air using a compression and distillation process. The remaining gaseous components of the air are vented to the atmosphere. Gaseous nitrogen, oxygen and argon are transferred by pipeline to the nearby Algoma Steel Mill. Intake water from the Lake Superior is supplied by Algoma Steel and is used at the plant as cooling tower make-up. Details on the plant, processes and wastewater generation are provided in the site visit report (Ref. 1).

**2.0      WASTEWATER SOURCES AND QUALITY**

**2.1      Wastewater Sources**

Domestic sanitary wastewater from the west end of the plant site flows to the municipal sanitary sewer. Sanitary wastewater from the east end of the plant site is discharged to a concrete sewage holding tank, whose contents are periodically hauled offsite. Floor drains in the maintenance/stores building in this area also flow to the same concrete sewage holding tank through an underground oil/water separator.

All other wastewater sources, including cooling tower blowdown, storm water and compressor condensate are collected in a common sump prior to discharge to a single storm sewer which was monitored as part of the MISA Regulation Monitoring Program at Control Point CO0100. The effluent is then discharged to an open ditch leading to Davigneaux Creek and ultimately to the St. Mary's River.

The only process wastewater generated in the production of nitrogen, oxygen and argon is air compressor condensate, at an estimated rate of 16 m<sup>3</sup>/d. This condensate is directed through an oil/water separator before combining with other flows in a common sump. Cooling tower blowdown passes through a cyclone separator to remove solids (as a slurry). The treated water is returned as make-up water to the cooling tower, and the slurry is discharged to the common sump. Storm water collected in the storm sewer system servicing the central area of the plant site also flows to the common sump. This sump allows for limited settling to occur prior to discharge through MISA Control Point CO0100.

During the MISA Regulation Monitoring period, the average discharge rate through Control Point CO0100 was 672 m<sup>3</sup>/d.

## 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents the average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for the MISA Control Point CO0100 at the Linde, Sault Ste. Marie site.

## 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, should be considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Each of these options are addressed in the following discussion.

### BAT Option 1

Toxicity data were collected, compiled and verified for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment. Four rainbow trout tests and four Daphnia magna tests were carried out on samples taken at Control Point CO0100. All of the trout samples were non-lethal. The results of the Daphnia magna tests ranged from greater than 100 percent to non-lethal, with 3 non-lethal samples. Thus, the existing wastewater management system was defined as BAT Option 1.

### BAT Option 2

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition), subpart AW for the Oxygen and Nitrogen Production Subcategory, BAT was not defined. However, limitations for oil and grease and pH based on the best practicable control technology (BPT) currently available were defined for this subcategory. These recommendations are presented in Table 1 and are compared to actual data for the Sault Ste. Marie site, based on MISA Monitoring Regulation results.

<p align="center"><b>Table 1</b> <b>U.S. EPA BPT Limits Compared to Data from Sault Ste. Marie Plant</b></p>				
Parameter	BPT Effluent Limits <sup>1</sup>		Actual Values	
	Maximum for 1 day	Average of Daily Values for 30 Consecutive Days	Maximum for 1 day <sup>2</sup>	Average Yearly Value <sup>3</sup>
Oil and Grease (kg/tonne of product)	0.0020	0.0010	0.0035	0.0013
pH	6.0 to 9.0	6.0 to 9.0	6.2 -9.2 <sup>4</sup>	8.5 <sup>4</sup>
<p>Notes:</p> <ol style="list-style-type: none"> <li>(Ref. 3).</li> <li>Based upon the maximum concentration and the average flow.</li> <li>Range of daily values for 30 consecutive days was not available.</li> <li>Since pH has both a minimum and maximum range, the minimum and the maximum daily values are presented for comparison.</li> </ol>				

The values calculated for final oil and grease loadings at the Sault Ste. Marie plant show that these were insignificantly higher than the BPT limits on average, and slightly exceeded the maximum daily limit at least once. The average pH limits were met, however, the maximum daily pH reading over a year was slightly exceeded at least once. Thus, in general, the Linde-Sault Ste. Marie plant is in compliance with the U.S. EPA

BPT. However, the frequency of excursion from the maximum daily limit should be investigated. If excursions occur frequently, the source of the oil and grease should be identified and controlled.

BAT Option 2 is defined as existing wastewater treatment at the Linde-Sault Ste. Marie plant.

### **BAT Option 3**

Five Ontario gas plants included in the Ontario Inorganic Chemical Sector were examined as part of this study. Each plant has unique operating features which are presented in Table 2. Examination of these features reveals no obvious best technology. Since no one plant could be considered as representing the best wastewater management system in the Province, BAT Option 3 is defined as the existing system at the Linde-Sault Ste. Marie plant.

### **BAT Option 4**

BAT Option 4 is intended to provide maximum overall pollution control. All contaminants resulting from plant operations are theoretically controllable. The possible sources of pollution originating from plant operations in the effluent include:

- Steam condensate
- Compressor condensate
- Cooling tower blowdown

Contamination originating from the steam can be ruled out since the steam is non-contact and therefore should be distilled water.

Compressor condensates have been shown to contain oil and grease in varying amounts, depending on the type, maintenance, and age of the compressor. At the Linde-Sault Ste. Marie plant, the oil and grease from the compressor condensate is already treated using a gravity oil/water separator prior to discharge to the MISA Control Point. An undetermined amount of oil/grease may also originate from the stormwater or the raw water. Since the oil and grease levels in the plant effluent are very low (2.2 mg/L), BAT Option 4 does not include reduction of oil and grease levels in the effluent.

Apart from the oil/grease, the compressor condensate is basically moisture from atmospheric air, and it is unlikely that this is a source of any other contaminants.



**Table 2**  
**Comparison of Operating Features at Five Ontario Gas Plants**

Plant	Operating Feature
Linde (Division of Union Carbide Canada Ltd.) - Moore Township	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sarnia	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 735</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Bird-Archer 3057</li> </ul> </li> <li>• Municipal water source.</li> </ul>
Linde (Division of Union Carbide Canada Ltd.) - Sault Ste. Marie	<ul style="list-style-type: none"> <li>• Cooling tower used.</li> <li>• Water treatment chemicals include:               <ul style="list-style-type: none"> <li>- Dearborn 546</li> <li>- Dearborn 726</li> <li>- Dearborn Poly-E1-PH905</li> <li>- Dearborn 747</li> </ul> </li> <li>• Cooling tower blowdown solids are concentrated in a cyclone separator prior to discharge.</li> <li>• Water source- Lake Superior.</li> </ul>
Liquid Carbonic Inc. - Courtright	<ul style="list-style-type: none"> <li>• Once through non-contact cooling water.</li> <li>• Water source- ICI Nitrogen Products, Lambton Works</li> </ul>
Liquid Carbonic Inc. - Maitland	<ul style="list-style-type: none"> <li>• Both once through and cooling tower non-contact cooling water is used.</li> <li>• Water treatment chemicals:               <ul style="list-style-type: none"> <li>- Betz C63P (bromine)</li> <li>- Betz MS-120</li> <li>- Betz J-12</li> <li>- Betz 35106</li> <li>- Betz K-1-2</li> </ul> </li> <li>• Water source- onsite well.</li> </ul>

Cooling tower operations contribute contaminants through the addition of water treatment chemicals, as a result of corrosion of system materials and through the concentrating effect of the nature of its operation.

The water treatment chemicals are likely a direct source of phosphates and may be an indirect source of the chloroform. The raw water is treated with a biocide, Dearborn 747, which is an 11 percent solution of sodium hypochlorite. Although residual chlorine was not monitored as part of the MISA Monitoring Regulation, this treatment chemical may have reacted with organics in the cooling water to produce chloroform. Since raw

water quality data were not available, the possibility for the raw water being the primary source of the chloroform also exists.

If an alternative water treatment chemical is considered, other chemicals will be introduced into the plant effluent. The mean concentration of phosphorus was 1.07 mg/L and the mean concentration of chloroform was 0.004 µg/L. These concentrations are not excessive and replacement of the chemicals may not improve the existing conditions significantly (Ref. 6). Hence, BAT Option 4 does not consider replacing the water treatment chemicals.

Although corrosion has been identified as a source of copper in some gas plants in the U.S. (Ref. 2 and Ref. 5), there is no concrete evidence that corrosion is a problem at the Linde-Sault Ste. Marie plant. The mean copper concentration at the Sault Ste. Marie plant (332 µg/L) is higher than the mean effluent concentrations at the other gas plants, but it is still not considered to be excessive. The elevated copper concentrations are likely a result of the concentrating effects of the operation of the cooling tower coupled with the practice of removing the solids from the cooling tower blowdown using a cyclone separator, and discharging this slurry with the final effluent. Hence, copper removal was not considered for BAT Option 4.

A review of remaining contaminants detected in the final effluent indicates that most of these are not generated in the process, but may be the result of raw water contaminants concentrated by cooling tower operation. These contaminants include; TSS including metal precipitates, nitrates and TKN, chloride, fluoride and sulphate.

Technologies for the removal of these low levels of contaminants present in the effluents may be available and have been used in specific non-industrial applications (e.g. drinking water treatment). However, an exhaustive, global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations. Thus, BAT Option 4 does not include technologies for removal of these contaminants.

Priority 1 contaminants with no specific process source include total heptachlorodibenzodioxin (H7CDD), methylene chloride, and octochlorodibenzo-p-dioxin. Careful review of the processes, raw materials, products and chemicals used at the plant within the scope of this study did not reveal a source of these contaminants. An audit of the possible sources of these contaminants are necessary, and reduction or elimination of these contaminants in discharges will be based on source controls through process changes, materials substitution, or best management practices.

Based on the above discussion, BAT Option 4 is defined as the existing system at the Linde, Sault Ste. Marie Plant.



## **BAT Option 5**

Technologies that would advance the plant further toward zero-discharge of contaminants were not identified in a global search. Cooling water provided by once through non-contact and recirculation cooling tower systems are invariably used to cool process equipment in industrial gas manufacturing. Other cooling methods, such as closed-loop air cooled systems, would require very large capital expenditures, hydro-electric consumption and land area for expansive heat exchange equipment requirements, and would not be effective in warmer months in Ontario. Furthermore, opportunities for consumption of cooling tower blowdown or condensate do not exist in the production of nitrogen gas. Therefore, BAT Option 5 that represents the furthest zero contaminant discharge was recommended as the existing system.

## **Summary**

Table 3 presents a summary of BAT Options for the Union Carbide, Linde Sault Ste. Marie plant.

<b>Table 3</b> <b>Summary of BAT Options for Union Carbide-Linde</b> <b>Sault Ste. Marie Plant</b>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost producing non-lethal effluent	No change to existing system.
2	U.S. BAT	No change to existing system.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum overall pollution reduction	No change to existing system.
5	Furthest towards zero-discharge of contaminants	No change to existing system.

## **4.0**

### **REFERENCES**

1. Inorganic Chemical Sector Plants Site Visit Report- Union Carbide Linde Division, Sault Ste. Marie Plant. April 1, 1991 (unpublished).
2. U.S. EPA, 1980. *Development Document for Effluent Limitations Guidelines and Standards for the Inorganic Chemicals Manufacturing Point Source Category*, EPA440/1-79/007.
3. U.S. Federal Register, 40 CFR Chapter 1, July 1, 1989 Edition.

4. Telephone and telefax communication with Bob Irwin of Dearborn Chemical Co. Ltd. Mississauga, Ontario, September 1989.
5. Telephone and telefax communication with Randy Fletcher of Linde - Union Carbide, Tonawanda, New York , July/Aug/Sept 1991.
6. General Technology Report, Water Treatment Chemicals for Boiler and Cooling Tower Make-up.

## **APPENDIX**

### **Figures and Tables**



**Table A1, Union Carbide Canada Ltd., Sault Ste. Marie**

Summary of Flows and Priority One Pollutants

MISA Control Point: CO0100

Description: Combined - Outfall At Safety Drive

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1.4	6670	672	
COD	mg/L	22	60	41	13.309
Hydrogen Ion (pH)		6.2	9.2	8.48	
Nitrate and Nitrite	mg/L	0.77	2.3	1.54	0.51
DOC	mg/L	0.9	21.4	9.6	8.647
TOC	mg/L	1.7	23	13.1	11.172
Total Phosphorus	mg/L	0.01	3.18	0.7	1.117
Specific Conductance	uS/cm	150	750	68	
Total Suspended Solids	mg/L	1	28	19	14.124
VSS	mg/L	10	1960	34.4	9.143
Aluminum	ug/L	20	2560	402	0.14
Boron	ug/L	10	1170	332	0.314
Copper	ug/L	40	200	144	0.086
Strontium	ug/L	20	280	166	0.119
Zinc	ug/L	0.9	17	8.95	0.004
Chloroform	ug/L	1.6	3	2.3	0.00155
*Methylene Chloride	ug/L	340	10000	5170	2.18E-05
*Total H7CDD	pg/L	2700	62000	32400	3.47E-06
*Octachlorodibenzo-p-dioxin	pg/L	1	6	2.2	0.99
Oil and Grease	mg/L	19	23	21	5.195
Chloride, Unfiltered Reactive	mg/L	0.2	0.4	0.3	0.047
Fluoride, Unfiltered Reactive	mg/L	26	40	33	8.973
Sulphate, Unfiltered Reactive	mg/L				

Note: \* These loadings were determined using the mean flow and mean concentration.

**Table A2**  
**Toxicity Data for Linde (Division of Union Carbide Canada Limited)**  
**Sault Ste. Marie Site for the First Six Months of MISA Monitoring Regulation**

Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-lethal Samples
Rainbow trout	4	all non-lethal	4
<u>Daphnia magna</u>	4	>100 % to non-lethal	3



Linde  
Sault Ste Marie

ATG	PARAMETER	CONCENTRATIONS		LOADINGS kg/d	
		RMDL	UNIT	CO 0100	CO 0100
c	Total suspended solids	5	mg/L	19.3	6.26
c	Hydrogen ion (pH)			8.48	
c	Specific conductance		uS/cm	468	
c	DOC	0.5	mg/L	9.55	2.52
c	TOC	5	mg/L	13.1	3.39
c	Oil and grease	1	mg/L	2.25	0.617
c	Ammonia plus Ammonium	0.25	mg/L	0.073	0.026
c	Nitrate + Nitrite	0.25	mg/L	1.54	0.51
c	Total Kjeldahl nitrogen	0.5	mg/L	0.935	0.388
c	Total phosphorus	0.1	mg/L	1.07	0.268
09	Aluminum	30	ug/L	403	0.088
09	Boron	50	ug/L	677	0.295
09	Copper	10	ug/L	333	0.118
09	Strontium	20	ug/L	144	0.041
09	Zinc	10	ug/L	166	0.041
14	Phenolics (4AAP)	2	ug/L	2	0.001
16	1,3-Dichlorobenzene	1.1	ug/L	0.7	0.001
16	1,4-Dichlorobenzene	1.7	ug/L	1.1	0.001
16	Bromomethane	3.7	ug/L	3.39	0.002
16	Chloroform	0.7	ug/L	8.95	0.004
16	Cis-1,3-Dichloropropylene	1.4	ug/L	1.1	0.001
16	Methylene chloride	1.3	ug/L	2.3	0.001
17	Styrene	0.5	ug/L	0.63	—
24	Octachlorodibenzo-p-dioxin	30	pg/L	32400	—
24	Octachlorodibenzofuran	30	pg/L	285	—
24	Total H6CDD	30	pg/L	470	—
24	Total H6CDF	20	pg/L	308	—
24	Total H7CDD	30	pg/L	5170	—
24	Total H7CDF	30	pg/L	373	—
24	Total PCDD	20	pg/L	50	—
2	Cyanide Total	0.005	mg/L	0.021	0.001
98	Ftflow		m3/d	249	
11	Chloride	2	mg/L	21	5.2
12	Fluoride	0.1	mg/L	0.3	0.047
13	Sulphate	5	mg/L	33	8.97

Notes

CO0100 is the "Effluent from Outfall at Safety Drive".

This effluent is discharged to the St. Marys River and Lake Superior.

Flow data and loadings should be treated with caution; an estimation method was used for much of the monitored period.



**APPENDIX 25**

**Washington Mills Limited**



# ONTARIO INORGANIC CHEMICAL SECTOR PLANTS

## REPORT ON BAT OPTIONS

### WASHINGTON MILLS LIMITED

#### 1.0 PLANT DESCRIPTION

Washington Mills Ltd. in Niagara Falls, produces fused aluminum oxide abrasives. Molten aluminum oxide, formed in an electric arc furnace from the melting of raw materials bauxite, coke, iron borings and magnesium oxide, is cooled and solidified, crushed, and ground, and classified according to size for sale. By-product ferro-silicon is periodically removed from the furnace and crushed for sale.

Water from an onsite well is used for contact cooling of the furnace and cooling pots. Municipal water is used as make-up to a closed loop, non-contact cooling water system for the transformer and other furnace components. It is cooled by heat exchange with well water.

Details on the plant production processes and wastewater management system are provided in the site visit report (Ref. 1).

#### 2.0 WASTEWATER SOURCES AND QUALITY

##### 2.1 Wastewater Sources

Contact cooling water is the only process effluent generated in the production of aluminum oxide abrasives. Non-process related effluents include periodic overflow of a municipal water reservoir, used for the closed loop cooling system, and storm water.

Cooling water, storm water from production areas and municipal water overflow that had been settled in a series of three concrete overflow basins were monitored during the MISA Monitoring Regulation period at Control Point CO0100. Storm water from non-production areas was monitored at ST0200, and intake water from the onsite well at IN0400.

##### 2.2 Wastewater Flows and Quality

Table A1 in the Appendix presents average, maximum and minimum flow and concentration data for those contaminants defined by the Ministry of the Environment as "Priority 1" for MISA Control Point CO0100. Table A2 presents "Priority 1" contaminants for intake water measured at IN0400.

### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

#### BAT Option 1

Toxicity data collected and compiled for the first six months of the MISA Monitoring Regulation period by the Ministry of the Environment are presented in Table A3. Six tests on rainbow trout and Daphnia magna were carried out on samples collected at Control Point CO0100. All six samples were non-lethal to rainbow trout, while four of

---

1

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.



six were non-lethal to Daphnia magna. The remaining two samples had a minimum lethal concentration of 86 percent.

The toxicity results indicate that effluent at CO0100 is non-lethal to the test species, and therefore, no change to the existing system is recommended for BAT Option 1. There is insufficient information to evaluate the cause of the two toxic results. Further testing to confirm toxicity, and if required, a toxicity reduction study, would be recommended to achieve non-lethality on a continuing basis.

## **BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), BAT and effluent limitations were not defined for the abrasives manufacturing sub-category. Furthermore, a search for "sister" abrasives plants in the U.S. found that technologies for wastewater control more advanced than those existing in Ontario were not used (Ref. 2). Thus, a BAT Option 2 was not defined.

## **BAT Option 3**

Four abrasives manufacturing plants are included in the Ontario Inorganic Chemical Sector. All plants incorporate settling and recycle of contact cooling water with discharge of overflows. Table 1 presents a comparison of major process related contaminants discharged from the four plants. Since more advanced technologies are not being used for wastewater control at any Ontario plant, and the quality of effluents do not vary significantly from plant to plant, BAT Option 3 does not include any changes to the existing system at Washington Mills.

**Table 1**  
**Comparison of Effluents from Four Ontario Abrasives Plants <sup>1,2</sup>**

Parameter	Exolon ESK Company of Canada Ltd. <sup>3</sup>	Norton Advanced Ceramics of Canada Inc. <sup>4</sup>	Washington Mills Ltd. <sup>5</sup>	Washington Mills Electro-Minerals Corp. <sup>6</sup>
Flow (m <sup>3</sup> /d)	9,440	7,430	1,988	17,810
TSS				
mg/L	19	17	20	5.2
kg/d	185	123	41	94
Aluminum				
µg/L	280	1433	68	159
kg/d	2.7	10.7	0.14	2.8

**Table 1**  
**Comparison of Effluents from Four Ontario Abrasives Plants <sup>1,2</sup>**

Parameter	Exolon ESK Company of Canada Ltd. <sup>3</sup>	Norton Advanced Ceramics of Canada Inc. <sup>4</sup>	Washington Mills Ltd. <sup>5</sup>	Washington Mills Electro-Minerals Corp. <sup>6</sup>
<b>Oil &amp; Grease</b>				
mg/L	n.p.	1.5	6.1	1.2
kg/d	n.p.	11.5	12.2	20.7
Notes:				
1. Average flows and loadings, and mean concentrations measured over 12 months of MISA Monitoring Regulation period.				
2. Contaminant loads are not directly comparable and should be based on production rates. Production rates were unavailable for most plants.				
3. Measured at Control Point CO0100 at Exolon ESK.				
4. Measured at Control Point CO0200, CO0300 and CO0400 at Norton.				
5. Measured at Control Point CO0100 at Washington Mills Ltd.				
6. Measured at Control Point CO0100 and CO0200 at Washington Mills Electro-Minerals.				

#### **BAT Option 4**

Careful review of the process and quality of effluents (Table A1) at the plant indicate that the presence of most pollutants are not likely a result of plant operations. Aluminum, present in raw materials and products, is not present at excessive levels in effluents indicating no obvious contamination from raw materials or products. The fact that TSS levels of 20 mg/L are the same as those in raw water (Table A2), coupled with the lack of evidence of raw materials or product contamination, indicates that TSS are also contributed from the raw water.

Phenols and oil and grease are contaminants that may be contributed from the process. Because of the layout of the operations, oil leaks or spills from equipment during repairs would fall onto the floor and be washed into the settling basins with cooling water. Large oil spills are cleaned by means of vacuum trucks or booms and pads to skim the surface of the settling basin (Ref. 1). This approach appears to be effective, since mean oil and grease levels of 6 mg/L, were relatively low over the 12 month monitoring period. Management practices for source control of oil and grease releases to the settling basins are the recommended approach to further reduce oil and grease levels in effluents. These are discussed under BAT Option 4 in Section 4.0.

Oil and grease in effluents is the likely source of phenols, since no other general usage chemicals that would contain this contaminant are reportedly used at the plant. Therefore, levels of this contaminant would also be reduced with oil concentrations.

Relatively high levels of TSS, strontium, boron, sulphide and chloride, and dilute levels of COD, ammonia, TKN, DOC and aluminum are likely originating from the raw well

water used at the plant. Some removal of most of these contaminants could be accomplished through a well water treatment system that included oxidation of sulphide (e.g. peroxide addition) and coagulation and sedimentation for removal of solids, strontium and other contaminants. However, implementation of several additional treatment processes will produce related problems which must be addressed, including:

- The impacts of water treatment chemicals on effluents, in terms of contaminant concentrations and toxicity.
- The handling and disposal of wastewater treatment residuals.
- The dependence of system reliability and operator training on performance.

Because of these problems, the preferred approach to controlling discharges of pollutants is pollution prevention.

Pollution prevention, involving the use of an alternate, uncontaminated water source at the plant, is recommended for BAT Option 4, and discussed in more detail in Section 4.0.

#### **BAT Option 5**

Technologies that would advance the plant further towards zero-discharge were not identified in the global search.

The plant already recycles cooling and storm water from the settling basins, to minimize the amount of intake water required and effluents discharged. However, the rate of recycle is dependent on the temperature required for cooling. Therefore, recycle rates tend to decrease in summer and increase in winter. Further increase of these rates would only be possible with expanded equalization ponds, to allow for greater heat transfer, or more elaborate air cooled or refrigerated systems. None of these systems are considered practical due to the very large capital expenditures, and expansive land area or electricity requirements. Therefore, these approaches to cooling are not recommended.

In aluminum oxide abrasives manufacturing, by-product ferro-silicon and other impurities collect in the bottom of the furnace. Periodically, this material is super-heated and poured out of the furnace. This procedure requires considerably more heat than for melting aluminum oxide, and results in substantial damage to the furnace refractory lining (usually bricks). The cooling method currently used, involving cascading water, is considered the only way to prevent major accidents in these instances. A water cooled jacket, for example, would be severely damaged and would not function adequately under these circumstances.

Zero-discharge of contaminants associated with contact cooling water would result if cooling water were non-contact, as would be the case if, for example, furnace cooling jackets were used. Reports from the abrasives industry (Ref. 3) indicate that this is not a feasible approach.

Based on the above discussion, BAT Option 5 is the same as BAT Option 4, since feasible technologies that would advance the plant further towards zero-discharge were not identified.

## Summary

Table 2 presents a summary of BAT Options defined for Washington Mills.

Table 2 Summary of BAT Options for Washington Mills Limited		
BAT Option	Definition	Description
1	Least cost producing non-lethal effluents	No change to existing system.
2	U.S. BAT	No U.S. BAT defined.
3	Best demonstrated in Ontario	No change to existing system.
4	Maximum reduction of pollutants	Best management practices for oil and grease and use of an alternate water source.
5	Furthest towards zero-discharge of pollutants	Same as Option 4.

## 4.0 BAT OPTIONS

BAT Option 1, 2 and 3 do not incorporate changes to the existing wastewater management system at Washington Mills. Technologies recommended for BAT Options 4 and 5 are discussed below.

### 4.1 BAT Options 4 and 5

#### Description

BAT Options 4 and 5 include two technology changes for maximum reduction of pollutants in effluent discharges. These include:

- Management practices for source control of oil and grease and phenol discharges.



- Use of an alternate intake water source to replace the well water currently used.

Management practices for source control of oil and grease releases will include diligent collection of oils during equipment maintenance and repair, routine inspection of equipment for oil leaks, containment of higher risk leak and spill areas, placement of absorbent socks and pads around equipment, employee training on oil spill procedures, etc. Some of these practices are already used at the plant, including training for clean-up of oil spills, and defined procedures of clean-up.

Two intake water sources could be considered to replace the intake well water at the plant: Niagara Falls municipal water supply and Welland Canal water.

For the municipal alternative, it is assumed that the municipal water supply system has sufficient capacity to meet the water demand exerted by the plant, and upgrading would not be required. Therefore, the only capital requirements would be in-plant water distribution piping changes. Operating costs for water would be significant.

If Welland River were to be selected as the intake water source, an intake, pipeline and pumphouse would be required to transfer water to the plant about 500 m away from the River. This alternative would have a high initial capital cost, but minimal operating costs. In addition, the need for a Certificate of Approval under the Ontario Water Resources Act adds an additional level of complexity to this alternative.

### **Performance**

The performance of the implementation of BAT Option 4 changes are presented in Table 3.

Oil and grease levels are estimated to reduce with implementation of management practices to achieve the lowest mean monthly concentration observed over the 12 month MISA monitoring period on a consistent basis. Removal efficiency of phenols is estimated to be equivalent to efficiency for oil and grease.

Projected concentrations and loading reductions for target pollutants in intake water are based on Welland River water quality. If municipal water were used, reduction would likely be higher. Dilute levels of contaminants in well water, such as COD, ammonia, TKN, DOC and aluminum are not significantly different than those in Welland River water (as measured at Norton Canada Inc. intake during the MISA Monitoring Regulation period).

<p align="center"><b>Table 3</b> <b>Projected Performance of Implementing BAT Option 4</b></p>					
Technology	Contaminant	Existing <sup>1</sup>		Projected	
		Mean Concentration	Average Loading	Mean Concentration	Average Loading <sup>3</sup>
Management practices for source control of oil and grease	Oil and grease	6.1 mg/L	12.2 kg/d	2.4 mg/L <sup>2</sup>	4.8 kg/d
	Phenolics	5 µg/L	0.011 kg/d	2 µg/L <sup>4</sup>	0.004 kg/d
Alternative water source	Sulphide	130 µg/L	0.267 kg/d	10 µg/L <sup>5</sup>	0.02 kg/d
	Boron	808 µg/L	1.61 kg/d	79.9 µg/L <sup>5</sup>	0.16 kg/d
	Strontium	14,866 µg/L	21.1 kg/d	178 µg/L <sup>5</sup>	0.36 kg/d
	Chloride	2,230 mg/L	4,491 kg/d	15.4 mg/L <sup>5</sup>	31.0 kg/d
	TSS	20.4 mg/L	41.1 kg/L	10.1 mg/L <sup>5</sup>	20.3 kg/d
<p>Notes:</p> <ol style="list-style-type: none"> <li>1. From 12 months of MISA Monitoring Regulation data.</li> <li>2. Based on lowest mean monthly concentration measured over 12 month monitoring period.</li> <li>3. Calculated from mean concentration and average flow.</li> <li>4. Based on removal efficiency the same for phenols and oil and grease.</li> <li>5. Welland River intake water monitoring data from the MISA Monitoring Regulation period at Norton Canada Inc.</li> </ol>					

## Costs

Costs for implementing management practices for oil and grease control can not be calculated in detail, since the necessary changes to the plant and employee training programs could not be defined within the scope of this study. It is however, reasonable to assume that these would not be high, and would total less than \$25,000 capital for minor changes around the plant, such as containment implementation. Negligible costs were assumed for including oil control procedures in staff training programs, and other routine operating requirements.

Costs for each of the alternate water sources are presented in Table 4. Capital cost estimates were based on in-house information and the general technology report for pumping stations and force mains (Ref. 4). All capital cost estimates should be considered order-of-magnitude.

## 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 5 presents a summary of estimated costs and projected performance of implementing BAT options at Washington Mills.



**Table 4**  
**Capital and Operating Cost Estimates for Alternative Raw Water Source at Washington Mills Limited**

Source	Item	Capital Cost <sup>1</sup>	Annual Operating Cost <sup>2</sup>
Welland River	Intake and pumping station (17 L/s)	\$850,000	\$2,000
	Distribution main (1.4 km @ 150 mm dia.)	140,000	
	Total	\$990,000	
Municipal water	In-plant piping changes	\$10,000	\$280,000 <sup>3</sup>

**Notes:**

- Capital cost estimates include 15 percent engineering, 30 percent estimating contingency, 35 percent installation and 7 percent G.S.T. (ENR CCI 6343)<sup>2</sup>.
- 1991 dollars.
- Based on Niagara Falls water costs of \$0.512/m<sup>3</sup> (1991).

**Table 5**  
**Summary of Cost and Performance of BAT Options**

Component	BAT Options 1, 3, 5	BAT Option 4	
		Welland River	Municipal Water
Capital	\$0	\$1,015,000	\$35,000
Operating	\$0	\$10,000	\$280,300
<b>Performance</b>	<b>Contaminant Loading Reduction</b>		
Oil & Grease (kg/d)	0.0		7.4
Phenolics (kg/d)	0.0		0.007
Sulphide (kg/d)	0.0		0.25
Boron (kg/d)	0.0		1.59
Strontium (kg/d)	0.0		20.7
Chloride (kg/d)	0.0		4,460
TSS (kg/d)	0.0		20.8

## 6.0 INFORMATION SOURCES

- Inorganic Chemical Sector Plants Site Visit Report - Washington Mills Limited. March 25, 1991. (unpublished).
- Telephone contacts made to U.S. abrasives manufacturing facilities:
  - George Tasevski of Exolon-ESK in Buffalo, New York. August 1991.

<sup>2</sup> Engineering News Record Construction Cost Index

- Mark Rollins of Norton Company in Worcester, Massachusetts. August 1991.
  - Dean Venturine of Washington Mills, Niagara Falls, New York. August 1991.
3. Telephone conversation with Rick Chambers of Norton Advanced Ceramics Inc., July 1991.
  4. General Technology Report - Pumping Stations, Force Mains and Sewers.

## **APPENDIX**

### **Tables**



**Table A1, Washington Mills Abrasives, Washington Mills Ltd.,**

**Niagara Falls**

**Summary of Flows and Priority One Pollutants**

**MISA Control Point: CO0100**

**Description: Final Effluent**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	1320	2530	2014	
COD	mg/L	53	67	60	126.375
Ammonia Plus Ammonium	mg/L	1.1	1.3	1.2	2.53
Total Kjeldahl	mg/L	1.6	2.8	2.2	4.608
DOC	mg/L	0.35	1.8	2.11	4.479
Specific Conductance	uS/cm	370	674	5940	
Total Suspended Solids	mg/L	9	16.5	20.4	41.086
Aluminum	ug/L	9	320	67.8	0.144
Boron	ug/L	9	3700	808	1.611
Strontium	ug/L	340	57000	10700	21.05
Phenolics (4AAP)	ug/L	3	7	5	0.011
Sulphide	ug/L	20	240	130	0.267
Oil and Grease	mg/L	0.96	59	6.14	12.233
Chloride, Unfiltered Reactive	mg/L	44	2900	2230	4490.803
Fluoride, Unfiltered Reactive	mg/L	0.7	0.7	0.7	1.48
Sulphate, Unfiltered Reactive	mg/L	60	940	727	1463.934

Note: Flow data for Sept. 1990 is suspect. Therefore a Dec. 1991 flow measure was included in the testing and was used in the calculation of the max., min., and mean Flow values. The total suspended solids, chloride unfiltered, and sulphate unfiltered are calculated based on the revised calculated flows.

**Table A2, Washington Mills Abrasives, Washington Mills Ltd.,  
Niagara Falls**

**Summary of Flows and Priority One Pollutants**

**MISA Control Point: IN0400**

**Description: Intake**

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
Specific Conductance	uS/cm	370	6710	5940
Total Suspended Solids	mg/L	2	46.5	20.4
Chloride, Unfiltered Reactive	mg/L	44	2900	2230
Sulphate, Unfiltered Reactive	mg/L	60	940	727



**Table A3**  
**Toxicity Data for Washington Mills Ltd. for the First Six Months of**  
**MISA Monitoring**

Control Point	Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-Lethal Samples
CO0100	Rainbow trout <u>Daphnia magna</u>	6 6	non-lethal 85.7% to non-lethal	6 4

**Washington Mills  
Niagara Falls**

		CONCENTRATIONS				LOADINGS kg/d	
ATG	PARAMETER	RMDL	UNIT	CO 0100	IN 0400	CO 0100	IN 0400
c	Total suspended solids	5	mg/L	22.1	21.4	46.6	43.9
c	Hydrogen ion (pH)			7.44	7.13		
c	Specific conductance		uS/cm	5900	6190		
c	DOC	0.5	mg/L	2.11	1.9	4.48	3.9
c	TOC	5	mg/L	2.95	1.25	6.16	2.56
c	Oil and grease	1	mg/L	6.13	11.9	12.3	24.3
c	Ammonia plus Ammonium	0.25	mg/L	1.2		2.53	
c	Nitrate + Nitrite	0.25	mg/L	0.034		0.072	
c	Total Kjeldahl nitrogen	0.5	mg/L	2.2		4.61	
c	Total phosphorus	0.1	mg/L	0.066		0.134	
09	Aluminum	30	ug/L	67.8		0.144	
09	Boron	50	ug/L	808		1.61	
09	Strontium	20	ug/L	10700		21.1	
14	Phenolics (4AAP)	2	ug/L	5		0.01	
15	Sulphide	20	ug/L	130		0.267	
98	Flow		m3/d	2050			
11	Chloride	2	mg/L	2230	2370	4530	4870
12	Fluoride	0.1	mg/L	0.7	690	1.48	1.41
13	Sulphate	5	mg/L	727	727	1480	1490

**Notes**

CO0100 is the "Final Effluent" which flows to the Welland River and Lake Ontario.

Flow and loading values should be treated with caution; a flow monitoring primary device with modified geometry and hydraulic arrangement and of unestablished accuracy was used.

Intake loadings displayed are based on mean discharge flow rate and intake wellwater analyses.

## **APPENDIX 26**

**Washington Mills Electro Minerals Corp.**



# **ONTARIO INORGANIC CHEMICAL SECTOR PLANTS REPORT ON BAT OPTIONS WASHINGTON MILLS ELECTRO MINERALS CORPORATION**

## **1.0 PLANT DESCRIPTION**

Washington Mills Electro Minerals Corporation, in Niagara Falls, produces primarily fused aluminum oxide abrasives and other abrasive materials when markets exist. Molten aluminum oxide is formed in an electric area furnace through the melting of bauxite, coke and iron borings which are the major raw materials of the process. Other minor raw materials include, at various times, magnesium oxide, chrome ore, chromium oxide and silica sand. The molten product is poured, cooled and solidified prior to crushing, grinding and size classification required for sale. By-product ferro-silicon is periodically poured from the furnace and is also solidified, crushed and sold when markets exist.

The process involves the use of contact cooling water drawn from the Welland River.

Details on plant production processes and wastewater management are provided in the site visit report (Ref. 1).

## **2.0 WASTEWATER SOURCES AND QUALITY**

### **2.1 Wastewater Sources**

Contact cooling water is the only process effluent generated in the production of manufactured abrasives at this plant. Non-process related effluents consist entirely of storm water collected from the plant site.

Contact cooling water is combined with a small fraction of the storm water flows from the plant site prior to passing through one of two compartmentalized concrete settling basins. The remainder of the storm water flows directly to natural waterways or municipal storm sewers. The combined streams were monitored during the MISA Monitoring Regulation as MISA Control Points CO0100 and CO0200. Monitoring of two other storm water discharge points (ST0800 and ST0900) and intake water (IN1200) was also conducted.

### **2.2 Wastewater Flows and Quality**

Tables A1 and A2 in the Appendix present average, maximum and minimum flow and concentration data as well average daily loadings, for those contaminants defined by the

### 3.0 RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, five BAT options for wastewater management, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1 - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2 - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3 - A BAT option that uses the best technology currently in use in Ontario.
- Option 4 - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5 - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

#### BAT Option 1

Toxicity data collected and compiled for the first six months of the MISA monitoring period by the Ministry of the Environment are presented in Table A3. Six samples

---

<sup>1</sup> Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.



were collected at each of the MISA Control Points CO0100 and CO0200 and tests were conducted on both rainbow trout and Daphnia magna. In all tests on trout, no fatalities were recorded and the effluents were deemed non-lethal. In six tests of CO0100 effluent on Daphnia magna, no deaths occurred in five tests and less than 50 percent mortality occurred in the sixth, resulting in greater than 100 percent non-lethality. In the six tests of CO0200 effluent on Daphnia magna, no deaths occurred in four tests and the minimum LC50 was 95.5 percent.

These toxicity results indicate that effluents at both CO0100 and CO0200 are non-lethal to the test species in a large majority of cases. Therefore, no change to the existing system is recommended for BAT Option 1. There is insufficient information to evaluate the cause of the three lethal results on Daphnia magna. Further testing to confirm toxicity, and if required a toxicity reduction study, would be recommended to achieve non-lethality to Daphnia magna on a constant basis.

### **BAT Option 2**

Under 40 CFR of the U.S. Federal Register (July 1, 1989 Edition), BAT, BPT and effluent limitations were not defined for the abrasives manufacturing sub-category. Furthermore, a search for "sister" abrasives plants in the U.S. found that technologies for wastewater control more advanced than those existing in Ontario were not used (Ref. 2). Thus, a BAT Option 2 was not defined.

### **BAT Option 3**

Four abrasives manufacturing plants are included in the Ontario Inorganic Chemical Sector. All of these plants incorporate settling and recycle of contact cooling water with discharge of overflows. Table 1 presents a comparison of major process related contaminants discharged from the four plants. Note that these data represent total mean daily loadings and total mean flows from all appropriate Control Points for a given site. Effluents from Washington Mills Electro Minerals compare favourably to other abrasives plant for the noted contaminants, especially with respect to total suspended solids which appear to be well controlled. Since more advanced technologies are not being used for wastewater control at any Ontario plant, BAT Option 3 is the existing wastewater system at Washington Mills Electro Minerals Corporation.

### **BAT Option 4**

Careful review of the process and quality of effluent (Tables A1 and A2) at the plant indicate that a number of contaminants including DOC, TOC, aluminum, strontium, chloride and sulphate are present at levels which are consistent with surface water quality in Ontario. Technologies for the removal of these low levels of contaminants

may be available and have been used in specific application (e.g. drinking water treatment). However, an exhaustive global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations.

**Table 1**  
**Comparison of Effluents from Four Ontario Abrasives Plants <sup>1,2</sup>**

Parameter	Exolon ESK Company of Canada Ltd. <sup>3</sup>	Norton Advanced Ceramics of Canada Inc. <sup>4</sup>	Washington Mills Ltd. <sup>5</sup>	Washington Mills Electro-Minerals Corp. <sup>6</sup>
Flow (m <sup>3</sup> /d)	9,440	7,430	1,988	17,810
TSS				
• mg/L	19	17	20	5.2
• kg/d	185	123	41	94
Aluminum				
• µg/L	280	1,433	68	159
• kg/d	2.7	10.7	0.14	2.8
Oil & Grease				
• mg/L	n.p. <sup>7</sup>	1.5	6.1	1.2
• kg/d	n.p. <sup>7</sup>	11.5	12.2	20.7
Notes:				
1. Average flows and loadings, and mean concentrations measured over 12 months of MISA Monitoring Regulation period.				
2. Contaminant loads are not directly comparable and should be based on production rates. Production rates were unavailable for most plants.				
3. Measured at Control Point CO0100 at Exolon ESK.				
4. Measured at Control Point CO0200, CO0300 and CO0400 at Norton.				
5. Measured at Control Point CO0100 at Washington Mills Ltd.				
6. Measured at Control Point CO0100 and CO0200 at Washington Mills Electro-Minerals.				
7. Oil and grease not a "Priority 1" parameter at Exolon ESK.				

Table A4 in the Appendix presents average, maximum and minimum flow and concentration data, as well as average daily loadings, for those contaminants defined by the Ministry of the Environment as "Priority 1" for MISA Control Point IN1200. It should be noted that concentrations of DOC and TSS appear to be lower in effluents than in intake water.

Total suspended solids appear to be well controlled by the two existing settling basins. Flow rate data and estimates of the amount of recycle at MISA Control Point CO0100 were used to confirm that surface loading rates are within the normal range for operation of primary settling units.

The remaining TSS in the effluents do not likely have their source in the process. This contention is supported by the fact that aluminum levels in the water are relatively low. Therefore, the two remaining possible sources are storm water and intake water.

Storm water is a relatively small fraction of the flows at Control Points CO0100 and CO0200 since the majority of storm water at the site drains to Control Points ST0800 and ST0900.

Intake water data (Table A4) indicate high levels of TSS and this is the most likely source of TSS loadings in the effluents. The most appropriate means to control these levels would be treatment of the raw water through conventional means such as coagulation and sedimentation plus filtration. However, the problems created in the handling and disposal of treatment residuals (e.g. filter backwash) would not be offset by the relatively small improvement in effluent quality which would result. Thus, BAT Option 4 does not include measures for the reduction of TSS.

Phenols and oil and grease are contaminants that may be contributed from the process. Because of the layout of the operations, oil leaks or spills from equipment during repairs would fall onto the floor and be washed into the settling basins with cooling water. Large oil spills are cleaned by means of vacuum trucks or booms and pads to skim the surface of the settling basin (Ref. 1). This approach appears to be effective, since mean oil and grease levels of approximately 1 mg/L for both effluent streams were relatively low over the 12 month monitoring period. Management practices for source control are the recommended approach to further reduce oil and grease levels in effluents. These are discussed under BAT Option 4 in Section 4.1.

Oil and grease in effluents is the likely source of phenols, since no other general usage chemicals that would contain this contaminant are reportedly used at the plant. Therefore, levels of this contaminant would also be reduced with oil concentrations.

### **BAT Option 5**

Technologies that would advance the plant further towards zero-discharge were not identified in the global search.

However, the plant currently practices recycle of cooling water only at MISA Control Point CO0100. Such recycling, although limited by the temperature required for cooling, reduces the amount of intake water required and the effluent discharged. Therefore, BAT Option 5 includes the recommendation to implement recycling of cooling water to the process from MISA Control Point CO0200. A detailed description of this option, as well as information on performance and costs, appears in Section 4.2 of this report.

Further increase of recycle rates would only be possible with expanded equalization ponds, to allow for greater heat transfer, or more elaborate air cooled or refrigerated systems. None of these systems are considered practical due to the very large capital expenditures, and expansive land area or electricity requirements. Therefore, these approaches to cooling are not recommended.

Zero-discharge of contaminants associated with contact cooling water would result if cooling water were non-contact, as would be the case if, for example, furnace cooling jackets were used. Reports from the abrasives industry (Ref. 3) indicate that this is not a feasible approach. In aluminum oxide abrasives manufacturing, by-product ferro-silicon and other impurities collect in the bottom of the furnace. Periodically, this material is super-heated and poured out of the furnace. This procedure requires considerably more heat than for melting aluminum oxide, and results in substantial damage to the furnace refractory lining (usually bricks). The cooling methods currently used, involving cascading water, is considered the only way to prevent major accidents in these instances. A water cooled jacket, for example, would be severely damaged and would not function adequately under these circumstances.

Based on the above discussion, BAT Option 5 includes management practices for oil and grease control and the implementation of recycling of cooling water to the process from MISA Control Point CO0200. This option is described in further detail in Section 4.2.

### Summary

Table 2 presents a summary of BAT Options defined for Washington Mills Electro Minerals.

<p align="center"><b>Table 2</b> <b>Summary of BAT Options for Washington Mills Electro Minerals</b></p>		
<b>BAT Option</b>	<b>Definition</b>	<b>Description</b>
1	Least cost production non-lethal effluents.	No change to existing system.
2	U.S. BAT.	No U. S. BAT defined.
3	Best demonstrated in Ontario.	No change to existing system.
4	Maximum reduction of pollutants.	Management practices for control of oil and grease.
5	Furthest toward zero-discharge of pollutants.	Same as BAT Option 4 with implementation of recycling from Control Point CO0200 to the process.

## **4.0**

### **BAT OPTIONS**

BAT Option 1, 2 and 3 do not incorporate changes to the existing wastewater management system at Washington Mills Electro Minerals Corporation. Technologies recommended for BAT Options 4 and 5 are discussed below.



## 4.1 BAT Option 4

BAT Option 4 consists of management practices for source control of oil and grease in effluent discharges.

### Description

Management practices for source control of oil and grease releases will include diligent collection of oils during equipment maintenance and repair, routine inspection of equipment for oil leaks, containment of higher risk leak and spill areas, placement of absorbent socks and pads around equipment, employee training on oil spill procedures, etc. Some of these practices are already in place at the plant, including training for clean-up of oils spills, and defined procedures for clean-up.

### Performance

The performance of the implementation of BAT Option 4 changes are presented in Table 3.

Table 3 Projected Performance of Implementing BAT Option 4					
Technology	Contaminant	Existing <sup>1</sup>		Projected	
		Mean Concentration	Average Loading	Mean Concentration <sup>2</sup>	Average Loading <sup>3</sup>
Management practices for source control of oil and grease.	Oil and grease Phenolics	1.2 mg/L 2.8 µg/L	20.7 kg/d 0.05 kg/d	1.0 mg/L 1.0 µg/L	17.8 kg/d 0.02 kg/d
Notes:					
1. From 12 months of MISA Monitoring Regulation data, averaged for the two Control Points.					
2. Based on lowest mean monthly concentration measured over 12 month monitoring period.					
3. Calculated from mean concentration and average flow.					

Oil and grease and phenol levels are estimated to reduce with implementation of management practices to achieve the lowest mean monthly concentration observed over the 12 month MISA monitoring period on a consistent basis.

## Costs

Costs for implementing management practices for oil and grease control can not be calculated in detail, since the necessary changes to the plant and employee training programs could not be defined within the scope of this study. It is however, reasonable to assume that these would be relatively small for minor changes around the plant, such as containment implementation. Negligible costs can also be assumed for including oil control procedures in staff training programs, and other routine operating requirements.

### **4.2            BAT Option 5**

BAT Option 5 includes the recommendations made for BAT Option 4 as well as implementation of contact cooling water recycling from MISA Control Point CO0200 to the process to reduce the volume of water discharged.

## Description

The rate of cooling water recycling achievable should be close to that of other abrasives plants or approximately 70 percent. In the case of Washington Mills Electro Minerals, MISA Control Point CO0200, this translates to a recycle flow rate of approximately 7,000 m<sup>3</sup>/d or 80 L/s. The technology required to implement this option includes the following items:

- Overflow structure from settling basin to pumping station.
- Pumping station, including pumps and control panels.
- Forcemain to connect with existing water supply lines.

## Performance

Since flow through the settling basin will be unchanged, the concentration of suspended solids in the effluent will be the same, averaging 5.2 mg/L. However, with the remainder recycled, suspended solids loadings will be reduced by 70 percent.

## Cost

Costs for this option have been developed from information in the general technology report for pumping stations, forcemains and sewers (Ref. 4), as well as from information provided by the company (Ref. 1). Costs are summarized in Table 4 and should be considered order of magnitude.



**Table 4**  
**Capital and Operating Cost Estimates for Recycling at MISA Control Point**  
**CO0200 at Washington Mills Electro Minerals**

Item	Capital Cost <sup>1</sup>	Annual Operating Cost <sup>2</sup>
Overflow structure	\$4,500 <sup>3</sup>	\$6,000
Pumping station	\$77,000	
Forcemain (100 m)	\$35,000	
Power Supply <sup>4</sup>	\$100,000	
<b>Total</b>	<b>\$216,500</b>	
Notes: 1. Capital cost includes 35% allowance for equipment installation, 30% estimating contingency, 15% engineering and 7% G.S.T. 2. 1991 dollars, including maintenance labour and materials, and electricity. 3. Estimate provided by company. 4. Power is currently unavailable at suitable pumping station location.		

It should be noted that these costs do not take into account any savings in the operation of intake water pumps which may be realized.

## 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 5 presents a summary of estimated costs and projected performance of implementing BAT options at Washington Mills Electro Minerals.

**Table 5**  
**Summary of Cost Performance of BAT Options**

Component	BAT Option 1, 2, 3	BAT Option 4	BAT Option 5
<b>Cost</b>			
Capital	\$0	small	\$216,500
Operating	\$0	-	\$6,000
<b>Performance (Contaminant Loading Reduction)</b>			
Total suspended solids (kg/d)	0.0	-	8.8 <sup>1</sup>
Oil and grease (kg/d)	0.0	2.9	-
Phenolics (kg/d)	0.0	0.03	-
Notes: 1. 70% reduction in TSS at CO0200, 0% at CO0100.			

## 6.0

### INFORMATION SOURCES

1. Inorganic Chemical Manufacturing Sector Plants, Site Visit Report, Washington Mills Electro Minerals Corporation. March 25, 1991. (unpublished).
2. Telephone contacts made to U.S. abrasives manufacturing facilities by S.A.I.C. - details currently unavailable.
3. Telephone conversation with Rick Chambers of Norton Advanced Ceramics, Inc., July 1991.
4. General Technology Report - Pumping Stations, Forcemains and Sewers.

## **APPENDIX**

### **Tables**



**Table A1, Washington Mills Ltd., Washington Mills Electro Minerals  
Corp., Niagara Falls**

**Summary of Flows and Priority One Pollutants**

MISA Control Point: CO0100

Description: Queen Lagoon

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	2880	10700	7610	
DOC	mg/L	0.6	17	3	19.927
Specific Conductance	uS/cm	255	423	286	
Total Suspended Solids	mg/L	0.5	5	5.9	41.978
Aluminum	ug/L	9		147	1.086
Strontium	ug/L		160	145	1.119
Phenolics (4AAP)	ug/L	1	6	2.3	0.019
Oil and Grease	mg/L	0.96	2.5	1.06	8.156
Chloride, Unfiltered Reactive	mg/L	14	15	14.5	129.043
Sulphate, Unfiltered Reactive	mg/L	23	25	24	211.307

**Table A2, Washington Mills Ltd., Washington Mills Electro Minerals Corp., Niagara Falls**

**Summary of Flows and Priority One Pollutants**

**MISA Control Point: CO0200**

**Description: Old Lagoon**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	5800	14000	10200	
DOC	mg/L	0.35	17	8.55	38.926
TOC	mg/L	0.8	16	3.9	37.683
Specific Conductance	uS/cm	260	6800	299	
Total Suspended Solids	mg/L	0.5	2800	5.2	52.091
Aluminum	ug/L			189	1.752
Strontium	ug/L	150	156	141	1.469
Phenolics (4AAP)	ug/L	1	9	2.7	0.031
Oil and Grease	mg/L	0.96	8.5	1.23	12.539
Chloride, Unfiltered Reactive	mg/L	15	15	15	152.591
Sulphate, Unfiltered Reactive	mg/L	23	24	23.5	240.19



**Table A3****Toxicity Data for Washington Mills Electro Minerals Corporation for the First Six Months of MISA Monitoring Regulation**

MISA Control Point	Test Species	Number of Samples	Range of Lethal Concentration Data	Number of Non-Lethal Samples
CO0100	Rainbow Trout	6	Non-lethal	6
	Daphnia magna	6	>100% to non-lethal	5
CO0200	Rainbow Trout	6	Non-lethal	6
	Daphnia magna	6	95.5% to non-lethal	4

**Table A4, Washington Mills Ltd., Washington Mills Electro  
Minerals Corp., Niagara Falls**

Summary of Flows and Priority One Pollutants

MISA Control Point: IN1200

Description: Welland River, Intake Water

Contaminant	Units	Concentration over 12 Month Sampling Period		
		Minimum	Maximum	Mean
DOC	mg/L	1.6	52	7.8
Specific Conductance	uS/cm	255	301	281
Total Suspended Solids	mg/L	0.6	60	8.8
Aluminum	ug/L	44	860	176
Strontium	ug/L	14	150	127

# Washington Mills Electro – Minerals

Niagara Falls

ATG	PARAMETER	CONCENTRATIONS					LOADINGS kg/d			
		RMDL	UNIT	CO 0100	CO 0200	IN 1200	CO 0100	CO 0200	IN 1200	
c	Total suspended solids	5	mg/L	5.78	5.05	5.98	40.8	51.4	107	
c	Hydrogen ion (pH)			7.82	7.85	7.76				
c	Specific conductance		uS/cm	286	284	282				
c	DOC	0.5	mg/L	3	3.55	7.77	19.9	38.9	140	
c	TOC	5	mg/L	3.07	3.92	1.08	23.5	37.8	19.4	
c	Oil and grease	1	mg/L	1.06	1.24	0.974	8.24	12.7	17.5	
c	Ammonia plus Ammonium	0.25	mg/L	0.038	0.033		0.317	0.342		
c	Nitrate + Nitrite	0.25	mg/L	0.17	0.16		1.49	1.62		
c	Total Kjeldahl nitrogen	0.5	mg/L	0.65	0.65		5.2	7.59		
c	Total phosphorus	0.1	mg/L	0.07	0.076		0.553	0.782		
09	Aluminum	30	ug/L	147	138	176	1.09	1.31	3.16	
09	Strontium	20	ug/L	145	141	127	1.12	1.46	2.28	
10	Selenium	5	ug/L	4.5	3		0.042	0.029		
14	Phenolics (4AAP)	2	ug/L	2.33	2.73	1.36	0.019	0.031	0.024	
15	Sulphide	20	ug/L	19.5	19.5		0.172	0.195		
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	3.45	1.65		0.028	0.017		
98	Flow		m3/d	7730	10200					
11	Chloride	2	mg/L	14.5	15		129	149		
13	Sulphate	5	mg/L	24	23.5		211	235		

Notes:

Flow and loadings values should be treated with caution; flow monitoring methods of unestablished accuracy were used.

CO0100 is the "Effluent from the Queen Lagoon". This discharges into the Welland River.

CO0200 is the "Effluent from the Old Lagoon" which is also discharged to the River.

Intake loadings are based on analytical data and on the sum of mean effluent flows.



## **APPENDIX 27**

**Welland Chemical Ltd.**





# **INORGANIC CHEMICAL SECTOR PLANTS**

## **REPORT ON BAT OPTIONS**

### **WELLAND CHEMICAL LTD.**

#### **1.0 PLANT DESCRIPTION**

Welland Chemical Ltd. in Sarnia, Ontario produces aluminum chloride and sodium hypochlorite as well as re-packaging chlorine gas into cylinders. The plant consists of three main units reflecting the three product lines.

Water is supplied to the plant by the City of Sarnia and is employed for equipment washdown, non-contact cooling, steam generation as well as sanitary purposes.

Details of the plant processes and wastewater management are presented in the site visit report (Ref. 1).

#### **2.0 WASTEWATER SOURCES AND QUALITY**

##### **2.1 Sources**

The sources and destination of wastewater discharges from the plant are presented in Table 1.

All sanitary waste goes to an onsite septic tank.

Once through non-contact cooling water sources are connected directly to the storm water collection system which drains to a local ditch. Cooling water discharges were monitored at MISA Control Points OT0300, OT0400 and OT0500.

Process related discharges include:

- Wash waters and wastewater from the chlorine filling unit.
- Wash waters from the sodium hypochlorite unit.
- Wash waters from the aluminum chloride unit.
- Surface runoff from the bin storage yard (aluminum chloride unit).

Wastewaters from the chlorine filling unit and sodium hypochlorite unit are discharged to Lagoon #2 which in turn discharges to Lagoon #1. The aluminum chloride unit wash waters and surface runoff from the bin storage yard are discharged to the South Lagoon. Both lagoons are currently individually batch discharged approximately ten times per year through MISA Control Points BA0200 (Lagoon #1) and BA0100 (South Lagoon).

**Table 1**  
**Sources and Destination of Wastewater**

Unit Area	Source of Wastewater	Rate of Generation	Destination
Chlorine filling unit	Container wash water and wastewater from hydrostatic testing of cylinders	200 L/d	Lagoon #2 to Lagoon #1 discharged through BA0200
	Air compressor cooling water.	0.17 L/s	Discharged through OT0300
	Air compressor condensate.	<5 L/d	Lagoon #2 to Lagoon #1 discharged through BA0200
Sodium hypochlorite production unit	Equipment wash water and floor drains.	300 L/d	Lagoon #2 to Lagoon #1 discharged through BA0200
Aluminum chloride unit	Air compressor condensate (east wall).	<5 L/d	Lagoon #2 to Lagoon #1 discharged through BA0200
	Air compressor condensate (south wall).	<5 L/d	South Lagoon discharged through BA0100
	Once through cooling water from air compressor (east wall).	0.17 L/s	Discharged through OT0400
	Once through cooling water from air compressor (south wall).	0.17 L/s	Discharged through OT0400
	Equipment wash water and floor drains from storage shipping area.	800 L/d	South Lagoon discharged through BA0100
	Chlorine vaporization baths (no additives).	2 batches/y	South Lagoon discharged through BA0100
	Bin storage yard storm runoff.	No data	South Lagoon discharged through BA0100
	Surface runoff from south-east to aluminum chloride building.	No data	South discharge outfall not monitored
	Tanker truck loading area.	No data	South discharge outfall not monitored

Welland Chemical employs hydrochloric acid to neutralize Lagoon #1 contents and lime to neutralize the South Lagoon contents prior to discharge.

## 2.2 Wastewater Flows and Quality

Tables A1 and A2 summarize flows, effluent concentrations and loadings from the South Lagoon and from Lagoon #1 respectively. The Tables present data for parameters defined by the Ontario Ministry of the Environment as "Priority 1" for Control Points BA0100 and BA0200.

Tables A3, A4 and A5 present flow and "Priority 1" contaminant concentration data for the three once through cooling discharges measured at Control Points OT0300 and OT-0400 and OT0500 respectively.

### 3.0

### RATIONALE FOR SELECTION OF BAT OPTIONS

In accordance with the study requirements, the following five BAT options for management of wastewater, with the exception of storm water runoff<sup>1</sup>, were considered for each Ontario Inorganic Chemical Sector plant:

- Option 1** - A least cost BAT option that achieves non-lethality to rainbow trout and Daphnia magna.
- Option 2** - A BAT option(s) selected by the U.S. EPA for comparable facilities in the U.S.
- Option 3** - A BAT option that uses the best technology currently in use in Ontario.
- Option 4** - A BAT option that is predicted to provide the maximum overall pollution reduction.
- Option 5** - A BAT option consisting of any current technology or combination of current technologies, including supplemental/add-on technologies, or cross-over technologies from other industrial sectors, which will advance the Ontario plant the furthest toward virtual elimination and the ultimate goal of zero discharge of contaminants.

Each of these options are addressed in the following discussion.

#### BAT Option 1

Toxicity data were collected and verified for the first six months of MISA Regulation monitoring period by the Ministry of the Environment and are presented in Table A6. The Table includes test data for each of the Control Points as well as data from a single test carried out on the intake water to the plant (Control Point IN0600).

<sup>1</sup>

Storm water runoff quality limits will be established separately under MISA, in conjunction with a program to conduct a Storm Water Control Study at each site.

Test results indicated that all effluents were lethal to trout and Daphnia magna. The single intake water sample also shows toxicity to both test organisms.

The likely source of toxicity in the intake water and once through cooling water streams is residual chlorine. Although no monitoring of total residual chlorine was carried out under the MISA program, it is reasonable to assume that residual chlorine from the municipal supply is still present at the intake to the plant and in the once through cooling water discharges.

Welland Chemical intends to eliminate the once through cooling water streams by conversion to air cooled compressors. This would also eliminate any toxicity problems associated with these streams.

Review of MISA monitoring data for the two lagoon discharges as well as monitoring carried out by Welland Chemical (Ref. 2) indicates that the primary source of toxicity in the Lagoon #1 effluent is likely total residual chlorine. Welland Chemical has since begun the addition of sodium metabisulphite as a dechlorinating agent which should eliminate this source of toxicity.

Another contaminant which may contribute to Lagoon #1 effluent toxicity is sulphide which is present at a mean concentration of 30 µg/L. Since sulphides are reactive with chlorine, it is not clear how sulphide is coexisting with chlorine in this effluent. The presence of sulphides should be confirmed by further monitoring.

The South Lagoon effluent contains elevated concentrations of aluminum as well as moderate concentrations of sulphides. These containments may contribute to the toxicity of the effluent.

Welland Chemical plans to combine the discharges from the two lagoons into a single discharge and has obtained a revised Certificate of Approval. The South Lagoon would be completely eliminated and decommissioned to be replaced by an approximately 23 m<sup>3</sup> concrete storage tank. Wastewater collected in the storage tank would be pumped to a Collection Pond which would also receive wash waters from the hypochlorite plant and from chlorine cylinder washing. Collection Pond effluent in turn would be pumped to the North Pond where effluent would be neutralized on an as needed basis. Effluent would be discharged only from the North Pond.

It is difficult to precisely anticipate the quality of the combined effluent because of potential interactions between discharges from the hypochlorite plant, chlorine container wash waters and discharges from the aluminum chloride plant. It is, however, reasonable to assume that, through reaction with free chlorine, sulphides will be eliminated from the new combined Welland Chemical effluent. The mechanism of this interaction would be similar to the use of alkaline chlorination for the treatment of sulphides through oxidation. The presence of a chlorine residual in the combined effluent would indicate that all sulphides has been oxidized and eliminated. Continued addition of sodium metasilphite (as needed) would also eliminate residual chlorine toxicity.



Residual aluminum concentrations in the new combined effluent could be reduced through pH adjustment. The optimum range for minimizing soluble aluminum is from pH 5.4 to 7.3. Depending upon circumstances acid or alkali could be added to the pond contents prior to discharge. Following a period of reaction and settling, the pond contents would be decanted. It is anticipated that aluminum concentrations achieved by this means would be non-toxic and typical of residuals in treated drinking water of about 300 µg/L.

Consequently, under BAT Option 1, the following measures are recommended:

1. Implementation of the modified effluent treatment system already approved by the Ontario Ministry of the Environment.
2. Elimination of sulphide concentrations reaction with free chlorine in the modified treatment system.
3. Elimination of residual chlorine concentrations by application of dechlorinating agent (sodium metabisulphite) in the modified treatment system.
4. Reduction of residual aluminum concentrations by adjustment of the pH of pond contents prior to batch discharge.
5. Careful monitoring of pH, sulphides, residual chlorine and residual aluminum prior to batch discharge of treated effluents.

Details of BAT Option 1 are presented in Section 4.0.

### **BAT Option 2**

Under 40 CFR Part 415 of the U.S. Federal Register (July 1, 1989 Edition) effluent limitations were not defined for either aluminum chloride or sodium hypochlorite manufacture. Therefore, a BAT Option 2 incorporating technologies selected by the U.S. EPA for comparable facilities, was not identified.

### **BAT Option 3**

Welland Chemical is the sole manufacturer of aluminum chloride in Ontario. Thus, BAT Option 3 was defined as the existing system at the Welland Chemical plant.

## **BAT Option 4**

The purpose of BAT Option 4 is to provide maximum overall water pollution control. Wastewater sources have already been presented in Table 1 and include effluents and wash waters from the three main processing areas as well as storm drainage.

Implementation of the measures already indicated under BAT Option 1 would be a necessary starting point for BAT Option 4. Additional management practices and effluent controls would however be necessary to further remove or reduce remaining constituents.

The proposed batch decant operation of the treatment system should minimize suspended solids levels in the combined plant effluent and therefore further measures are not recommended. Careful attention to pond outlet design will minimize any solids re-entrainment.

Oil and grease levels are already quite low. If additional reduction were felt necessary, an audit of potential oil and grease sources should be undertaken and in-plant management practices implemented to further reduce loadings.

Oil and grease in effluents is the likely source of phenols, since no other general usage chemicals that would contain this contaminant are reportedly used at the plant. Therefore, levels of this contaminant would also be reduced with oil concentrations.

Given the low concentrations of organic carbon, the high COD levels in the South Lagoon effluent are difficult to rationalize. One possibility may be interference in the COD analysis produced by the high levels of chloride. Generally, standard analysis procedures are not recommended for effluents with chlorides exceeding 2,000 mg/L (Ref. 2). COD analysis procedures should be reviewed and the effluent retested if necessary.

Concentrations of boron, strontium and zinc were noted in the effluents from both the South Lagoon and Lagoon #1. Cadmium was detected in the effluents from Lagoon #1. Likely these contaminants would still be observed in a combined effluent.

The concentrations of boron, strontium, and zinc are low. Technologies exist for removal of low level contaminants in non-industrial applications such as drinking water treatment. However, an exhaustive global search carried out as part of this study did not identify practical applications of these technologies to treating industrial wastewater effluents with similar contaminant concentrations.

Some additional cadmium removal will likely be achieved through the modified (consolidated) treatment system although this is likely to be minimal at the pH needed for aluminum reduction. An audit should be carried out to identify the source(s) of cadmium and through either material replacement or other source controls that the discharge of cadmium should be eliminated.



Both the South Lagoon and Lagoon #1 effluents contain a number of chlorinated organics at low concentrations including hexachlorobenzene and pentachlorobenzene. The specific source of these contaminants is not clear, although they may be by-products of chlorine reaction with other organic species. The preferred approach to reducing the discharge of these contaminants would be to preclude their formation either by process modification or substitution of materials not containing similar organic substrates. Treatment of these contaminants by stripping and adsorption or aqueous phase adsorption is felt not to be proven technology for industrial wastewaters at the observed concentrations. Accordingly, it is recommended that an audit be carried out to identify the source(s) of these trace organic contaminants and to recommend insofar as possible process or material changes aimed at minimizing their production and release.

Both the South Lagoon and Lagoon #1 discharges have elevated concentrations of chlorides. Presumably, the modified treatment scheme would result in similar chloride loadings. The chlorine loadings principally originate in the wash waters from the process areas. The total daily volume of these streams is small totalling about 1,300 L/d if all wash water streams are included. The levels of chlorides in the combined effluent would likely be on the order of 4,000 to 5,000 mg/L (assuming a mean of 6,900 mg/L from the aluminum chloride plant and a mean of 1,950 mg/L from the remainder of the plant). The technologies to treat these levels of chloride include:

- Preconcentration of the waste stream using reverse osmosis, ion exchange or electrodialysis. Flow rates of residuals requiring further treatment will total approximately 10 to 30 percent of the original flow.
- Further concentration of the waste stream through evaporative technologies such as vapour compression evaporation or steam-driven evaporation.
- Crystallization of the concentrated waste stream through the use of spray dryers or equivalent technologies.
- Disposal of resulting solid wastes.

Preconcentration technologies require careful control of operating conditions to avoid fouling or deterioration of membranes or resins and may require additional pretreatment steps such as removal of solids and/or organics. All of these technologies are both energy and labour intensive and will result in considerable capital costs as well as operational complexity. Further description of these technologies, as well as more detailed information on capital and operating costs, are provided in a separate report. Therefore, effluent treatment for chloride control is not recommended.

In this instance it would be preferable to implement strategies for controlling the degree of contamination of wash waters and for minimizing washwater volumes. Review of process operations will be needed to identify these opportunities.

In summary, the following measures are recommended under BAT Option 4:

- Implementation of the modified treatment system.
- Conversion of compressors to air cooling.
- In-plant management practices for oil and grease control.
- Source identification and control study for cadmium and selected organics.

### **BAT Option 5**

The elimination of once through cooling water through the replacement of water cooled air compressors in addition to the reuse of effluent treated in the modified system are the most practical means of bringing the Welland Chemical plant closest to zero discharge.

The amount of additional effluent reuse would need to be defined once the new treatment system is commissioned. Welland Chemical have targeted a 50% level of reuse but have as of yet not defined specific measures or costs needed to achieve their goal.

Thus, BAT Option 5 is defined as elimination of once through cooling waters used in air compressors and maximizing the reuse of the treated effluent discharge from the new treatment system, in addition to these recommendations for pollutant reduction and control presented in BAT Option 4.

### **Summary of BAT Options**

Table 2 presents a summary of BAT Options.

## **4.0 COST AND PERFORMANCE OF BAT OPTIONS**

BAT Options 2 and 3 do not incorporate changes to the existing wastewater management system at Welland Chemical. Best management practices and technologies recommended for BAT Options 1, 4 and 5 are discussed in the following sub-sections.

### **4.1 BAT Option 1**

BAT Option 1 involves the elimination of once through cooling waters by the conversion of all compressors to air cooling as well as implementation and operation of the

new combined effluent treatment system in a manner that will eliminate effluent toxicity.

**Table 2**  
**Summary of BAT Options for Welland Chemical Ltd.**

BAT Option	Recommendation
1	<ul style="list-style-type: none"> <li>• Implementation of modified treatment system.</li> <li>• Elimination of once through cooling water.</li> </ul>
2	<ul style="list-style-type: none"> <li>• Existing system.</li> </ul>
3	<ul style="list-style-type: none"> <li>• Existing system.</li> </ul>
4	<ul style="list-style-type: none"> <li>• Implementation of modified treatment system.</li> <li>• Elimination of once through cooling water.</li> <li>• In-plant management practices for oil and grease control of cadmium and selected organics.</li> </ul>
5	<ul style="list-style-type: none"> <li>• BAT Option 4.</li> <li>• Reuse of effluent.</li> </ul>

The modifications to the air compressors are listed in Table 3 and will involve replacement of one compressor unit and conversion to air cooling of three other units. The result will be the total elimination of all cooling waters previously used in air compressors and of any toxicity associated with them.

**Table 3**  
**Welland Chemical Air Compressor Modifications**

Existing	Proposed	Service
<ul style="list-style-type: none"> <li>• 25 hp Piston</li> <li>• Water cooled</li> </ul>	<ul style="list-style-type: none"> <li>• 75 hp Screw Type</li> <li>• Air cooled</li> </ul>	Process building and chlorine unit.
<ul style="list-style-type: none"> <li>• 25 hp Piston</li> <li>• 15 hp Piston (back up)</li> <li>• Water cooled</li> </ul>	<ul style="list-style-type: none"> <li>• Conversion to air cooling</li> </ul>	Padding air for chlorine rail cars.
<ul style="list-style-type: none"> <li>• 15 hp Piston</li> <li>• Water cooled</li> </ul>	<ul style="list-style-type: none"> <li>• Conversion to air cooling</li> </ul>	Service air in maintenance shops.

Non-toxic effluents should result through optimization of the modified effluent treatment system. This entails combining effluent discharges, and monitoring and adjusting quality prior to batch release. The new effluent treatment system is depicted in Appendix Figure A1. The system will include a pumping recirculation system to ensure adequate mixing in the North Pond. All the reagents necessary to provide pH adjustment,

dechlorination, or sulphide oxidation are presently employed onsite. Chemical feed systems already exist for both hydrochloric acid and lime. Sodium metabisulphite is added manually.

### Performance

The implementation of the proposed modifications to the air compressors and effluent treatment system would result in a non-toxic effluent.

### Costs

The cost of compressor conversion and replacement has been estimated by Welland Chemical to be \$75,000. The operating costs of the air coolers have not been estimated but would likely be in part offset by elimination of water purchase from the City of Sarnia. The plant currently utilizes approximately 46 m<sup>3</sup>/d of cooling water at a cost of \$22/d (water cost of \$0.48/m<sup>3</sup>).

The cost of the modified treatment system has been estimated by Welland Chemical to be \$500,000. This includes:

- Reroute drainage system to Centre Treatment Pond includes 30 gpm pump.
- Desludge and fill South Pond.
- Desludge and widen and deepen centre (treatment) pond includes 30 gpm pump.
- Widen/deepen North (holding/discharge) Pond includes 500 gpm pump.
- Reroute ground water.
- Recycle loop for effluent (proposed).
- Tri-level test posts for water sampling - ponds (proposed).
- Test equipment associated with discharge to offsite (proposed).

The costs of chemical reagent addition would depend on the further treatment requirements after the interaction of effluents from the various process areas. Welland Chemical's experience has shown that sodium metabisulphite addition involves small operating costs while pH control is currently practised and would likely not entail additional expense. Since the chemical feed systems are already in place no capital costs beyond the modification of the treatment system are anticipated.

## **4.2      BAT Option 4**

BAT Option 4 includes the changes indicated under BAT Option 1 to air compressors and the effluent treatment system as well as implementation of the following:



- BMPs for oil and grease and phenol control.
- Source identification and control for cadmium and selected organics.

#### 4.2.1 Oil and Grease Control

##### Description

In-plant management practices for control of oil and grease discharges cannot be specifically identified without a detailed understanding of the plant, and potential sources. Some general procedures that could be considered include:

- Containment of high risk oil leak or spill locations.
- Placing oil absorbent pads or socks around equipment.
- Using oil absorbent pads in wastewater collection sumps to absorb visible oil sheens.
- Implementation of a surface oil skimmer on the wastewater treatment plant settling tank.
- Other methods, depending on nature of discharge.

##### Costs

The costs of implementing an oil and grease control program should not be significant. A budget estimate of \$25,000 has been allowed for purchase of equipment and adsorbents.

##### Performance

The oil and grease removal performance resulting from implementation of management practices was arbitrarily estimated to be represented by the "best" month over the twelve month MISA Monitoring period. Estimated performance is presented in Table 4. It is assumed that phenolics levels are directly related to oil and grease levels.

**Table 4**  
**Projected Performance for Implementation of Best Management Practices for Oil and Grease Control**

Parameter	New Combined Effluent		
	Current Quality <sup>2</sup>	Projected Quality <sup>3</sup>	Loading Reduction
Oil & Grease (kg/batch))	0.31	0.19	63%
Oil & Grease (mg/L)	1.54	0.96	
Phenols (kg/batch))	0.007	0.0024	63%
Phenols (µg/L)	30	12	

Notes:

1. After installation of modified effluent treatment system.
2. Based on flow weighted averaging of 12 months of data for MISA Control Points BA0100 and BAA200.
3. Based on lowest monthly concentration data observed over 12 month monitoring period, and 12 month mean flow.

#### **4.2.2      Trace Organics and Cadmium Reduction**

##### **Description**

An audit will need to be undertaken to identify sources of cadmium and trace organics and recommend appropriate measures including materials substitution and source elimination. Since the Welland Chemical effluents contain a component of storm water, consideration should also be given to examining this potential source of contaminant loadings.

##### **Costs**

The cost of carrying out an audit inclusive of analyses is estimated for budget purposes to be \$25,000.

##### **Performance**

The complete elimination of cadmium and trace organics should in theory be achievable. In practice, depending upon the source of these contaminants, some reduction below current loadings will be possible.



Description

The details of the modified treatment were already discussed under BAT Option 1. The system would be operated in a manner to eliminate sulphide and chlorine residuals and to minimize the discharge of residual aluminum.

Costs

The estimated capital costs of the modified effluent treatment system was \$500,000. Additional operating costs for labour, utilities and chemical utilization are estimated to be small.

Performance

The actual performance of the new effluent treatment system is difficult to predict. The interaction of process streams as well as the addition of reagents for dechlorination or pH adjustment will all play a role in defining effluent quality.

Table 5 presents the "best" estimate of combined effluent quality and loading reduction for selected parameters.

<p align="center"><b>Table 5</b> <b>Projected Performance of Modified Effluent Treatment System</b></p>				
Parameter	Present		Projected	
	Concentration (mg/L)	Loading (kg/batch)	Concentration (mg/L)	Loading (kg/batch)
Sulphide	0.04	0.008	0	0
Aluminum	2.8	0.55	0.3	0.059
<p>Notes:</p> <ol style="list-style-type: none"> <li>Based on estimated quality and volume of current blended effluent. Concentration data are flow weighted.</li> <li>Assumes batch discharges equivalent to current combined volume.</li> </ol>				

#### 4.2.4

#### Elimination of Once Through Cooling Water

##### Description

The elimination of once through cooling water by the conversion of air compressors to air cooling was already discussed under BAT Option 1.

##### Costs

The estimated cost of conversion was \$75,000. No estimate of the new operating costs have been developed. The increase in utility cost for air coolers will be offset in part by the reduction in the water volume purchased from the City of Sarnia.

##### Performance

The implementation of air cooled compressors will eliminate the loadings in the cooling water streams of oil and grease and DOC. Table 6 presents the existing and projected loadings.

Table 6 Projected Performance for Implementation of Air Cooled Compressors		
Parameter	Existing Loading <sup>1</sup> (kg/d)	Projected Loading (kg/d)
Oil and Grease	0.06	0.0
DOC	0.07	0.0
Notes:		
1. Combined loading from all once through cooling water streams (OT0300, OT0400, OT0500).		

#### 4.3

#### BAT Option 5

##### Description

BAT Option 5 includes the elimination of once through cooling water discharges as well as other controls recommended for pollutant reduction under BAT Option 4. In addition, Welland Chemical has indicated that they are examining up to a 50% reduction in effluent discharge by reusing the final effluent within the plant. The specific feasibility of achieving this degree of reuse has not been evaluated as yet.

## Costs

Until specific proposals for water reuse are detailed, no costs can be presented for recycling effluent. Furthermore, the cost of the modified treatment system, of \$500,000 may be high, because the capacity requirements would be reduced if untreated effluents were recycled. However, more detailed costs cannot be provided at this time.

## Performance

Until a reuse scheme has been specified and estimates prepared of effluent discharge quality and volume, it is not possible to specify a level of performance.

### 5.0 SUMMARY OF COST AND PERFORMANCE OF BAT OPTIONS

Table 7 presents a summary of estimated costs and projected performance of implementing BAT options at Welland Chemical. Estimates for the reduction in trace organics and cadmium were not included because of the uncertainties in the sources of these contaminants and the ability to completely eliminate effluent loadings.

Table 7 Summary of Cost and Performance of BAT Options for Welland Chemical			
Component	BAT Option 1	BAT Option 2, 3	BAT Options 4 and 5
Cost Summary			
Capital	\$575,000	0	\$575,000
Operating	small	0	\$25,000+
Study	0	0	\$25,000
Performance Summary (Loading Reduction) (kg/batch)			
Oil and grease	0.06	0	0.18
Phenols	0	0	0.0046
Aluminum	0.49	0	0.49
Sulphides	0.008	0	0.008
DOC	0.07	0	0.07

### 6.0 INFORMATION SOURCES

1. Inorganic Chemical Sector Plants Site Visit Report - Welland Chemical Limited. March 18, 1991 (unpublished).

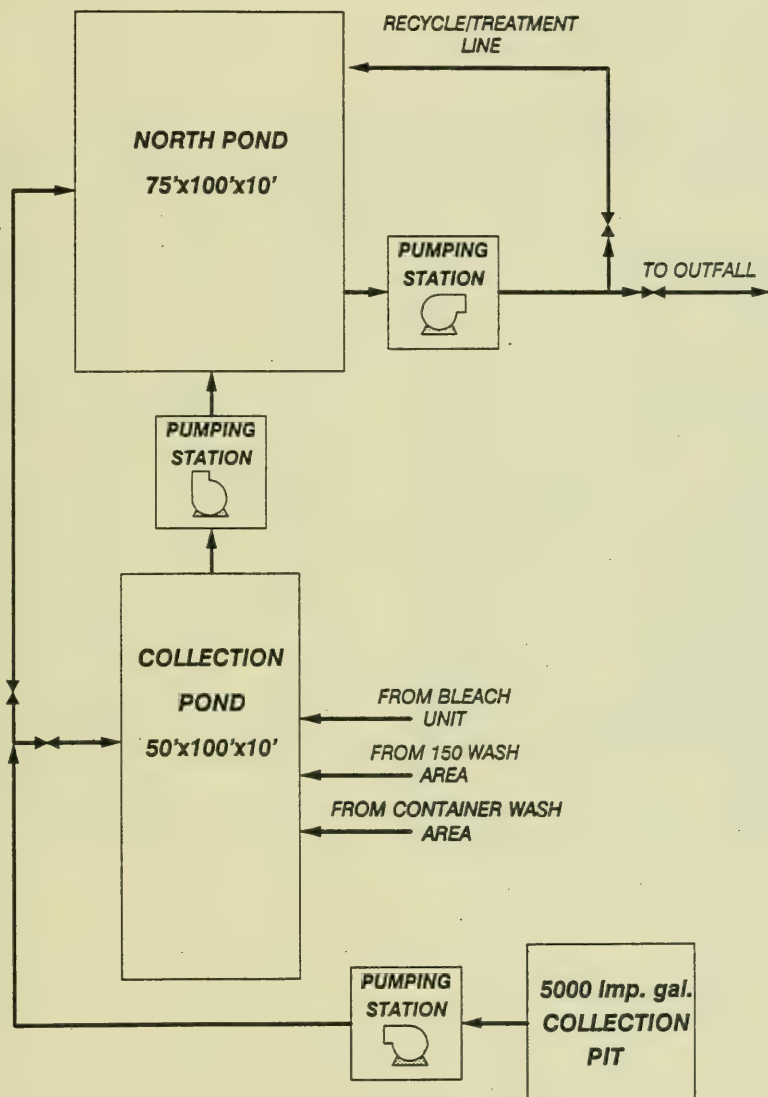
2. Ontario Ministry of the Environment Memorandum Regarding Amendments to Certificate of Approval for Wastewater Treatment and Collection System, Sarnia Area Office, October 4, 1990.

## **APPENDIX**

### **Figure and Tables**







**Figure A1**  
**PROPOSED CHANGES TO WELLAND CHEMICAL LTD.**  
**WATER COLLECTION SYSTEM**

**Table A1, Welland Chemical Ltd.**

Summary of Flows and Priority One Pollutants

MISA Control Point: BA0100

Description: Batch Discharge from South Lagoon

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading kg/batch
		Minimum	Maximum	Mean	
Flow	m3/batch	Not Avail.	Not Avail.	144	
COD	mg/L	150	340	245	35.28
Ammonia plus Ammonium	mg/L	0.16	5.5	2.47	0.36
Total Kjeldahl Nitrogen	mg/L	1.5	7	3.87	0.56
Nitrate & Nitrite	mg/L	0.98	1.8	1.18	0.17
DOC	mg/L	0.35	16	4.46	0.64
Specific Conductance	uS/cm	6300	26000	12600	
Total Suspended Solids	mg/L	12	28	28.6	4.12
VSS	mg/L	18	23	20.5	2.95
Aluminum	ug/L	1200	3700	3710	0.53
Boron	ug/L	30	90	47.6	0.0069
Strontium	ug/L	460	2400	1040	0.150
Zinc	ug/L	8	44	25.6	0.0037
Phenolics(4AAP)	ug/L	3	39	21	0.0030
Sulphide	ug/L	20	70	45	0.0065
Chloroform	ug/L	0.4	140	54.6	0.0079
Methylene Chloride	ug/L	0.3	4.6	1.71	0.00025
Hexachlorobenzene	ng/L	3	30	20.1	2.89E-06
Oil and Grease	mg/L	0.96	2.2	1.43	0.21
Chloride, Unfiltered Reactive	mg/L	3800	10000	6900	994

**Table A2, Welland Chemical Ltd.**

Summary of Flows and Priority One Pollutants

MISA Control Point: BA0200

Description: Effluent from Lagoon #1, Batch Discharge

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading kg/batch
		Minimum	Maximum	Mean	
Flow	m3/batch	Not Avail.	Not Avail.	54	
COD	mg/L	16	21	18.5	1.00
Total Kjeldahl Nitrogen	mg/L	0.2	8	1.64	0.089
Nitrate & Nitrite	mg/L	0.21	1.8	0.907	0.049
DOC	mg/L	0.7	30	6.92	0.37
TOC	mg/L	1.6	33	13.8	0.75
Specific Conductance	uS/cm	3000	15000	6780	
Total Suspended Solids	mg/L	4.2	21	10.4	0.56
Aluminum	ug/L	98	1300	443	0.023
Boron	ug/L	30	72	50.6	0.0026
Cadmium	ug/L	1	20	4.1	0.00021
Strontium	ug/L	70	500	496	0.026
Zinc	ug/L	4	110	26.5	0.0014
Phenolics (4AAP)	ug/L	42	110	76	0.0040
Sulphide	ug/L	20	40	30	0.0016
Dibromochloromethane	ug/L	0.4	4.9	2.04	0.00011
Chloroform	ug/L	0.4	310	90.7	0.0047
o-Xylene	ug/L	0.4	1	0.53	0.000028
Hexachlorobenzene	ng/L	3	54	13.2	7.13E-10
Pentachlorobenzene	ng/L	2.1	32	9.16	4.95E-10
Oil and Grease	mg/L	0.96	5.3	1.89	0.098
Chloride, Unfiltered Reactive	mg/L	1100	2800	1950	105
Fluoride, Unfiltered Reactive	mg/L	0.1	0.5	0.3	0.016
Sulphate, Unfiltered Reactive	mg/L	11	34	22.5	1.22

**Table A3, Welland Chemical Ltd.**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT0300

Description: Once-through cooling water from chlorine filling unit

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m <sup>3</sup> /d	10.8	17		
DOC	mg/L	0.5	1.39		0.024
Specific Conductance	uS/cm	155	186		
Oil and Grease	mg/L		4	1.51	0.026

**Table A4, Welland Chemical Ltd.**

Summary of Flows and Priority One Pollutants

MISA Control Point: OT0400

Description: Once through cooling water from aluminum choride (east wall)

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m3/d	11.5	13	11.9	
DOC	mg/L	0.7	3.5	1.56	0.019
Specific Conductance	uS/cm	152	198	186	
Oil and Grease	mg/L	1	3	1.25	0.015

**Table A5, Welland Chemical Ltd.****Summary of Flows and Priority One Pollutants****MISA Control Point: OT0500****Description: Once-through cooling water from aluminum chloride building (south wall)**

Contaminant	Units	Concentration over 12 Month Sampling Period			Loading (kg/d)
		Minimum	Maximum	Mean	
Flow	m <sup>3</sup> /d	14.4	20.2	17.2	
DOC	mg/L	0.5	1.96	1.44	0.025
Specific Conductance	uS/cm	150	200	186	
Oil and Grease	mg/L	1	2	1.08	0.018



**Table A6**  
**Toxicity Data for Welland Chemical Limited for the First Six Months of the**  
**MISA Monitoring Regulation**

MISA Control Point	Test Species	Number of Samples	Range of Data	Number of Non-Lethal Samples
BA0100	Rainbow Trout	4	64.6% to >100%	none
	Daphnia magna	3	66.9 % to 70.7%	none
BA0200	Rainbow Trout	4	2.5% to 51.1%	none
	Daphnia magna	3	1.7% to 70.7%	none
OT0300	Rainbow Trout	2	64.7% to >100%	none
	Daphnia magna	2	18.0% to 30.5%	none
OT0400	Rainbow Trout	2	>100%	none
	Daphnia magna	2	30.5% to 36.1%	none
OT0500	Rainbow Trout	2	>100%	none
	Daphnia magna	2	36.9% to 42.7%	none
IN0600	Rainbow Trout	1	62.5%	none
	Daphnia magna	1	18%	none

# Welland Chemical

Samia

Once Through Cooling – Monitored Parameters Only.

		CONCENTRATIONS					LOADINGS kg/d		
ATG	PARAMETER	RMDL	UNIT	OT 0300	OT 0400	OT 0500	OT 0300	OT 0400	OT 0500
c	Total suspended solids	5	mg/L	2.03	2.38	2.06	0.034	0.029	0.036
c	Hydrogen ion (pH)			7.27	7.37	7.37			
c	Specific conductance		uS/cm	186	186	186			
c	DOC	0.5	mg/L	1.39	1.56	1.44	0.024	0.018	0.025
c	TOC	5	mg/L	1.67	1.9	2.05	0.029	0.022	0.035
c	Oil and grease	1	mg/L	1.51	1.25	1.08	0.026	0.015	0.018
c	Total phosphorus	0.1	mg/L	0.100	0.100	0.100	0.002	0.001	0.002
98	Flow		m3/d	17	11.9	17.2			

## Batch Discharges

ATG	PARAMETER	RMDL	UNIT	CONCENTRATIONS			LOADINGS kg/d		
				BA 0100	BA 0200	IN 0700	BA 0100	BA 0200	IN 0700
c	Total suspended solids	5	mg/L	28.6	10.4		3.5	1.74	
c	Hydrogen ion (pH)			7.56	7.66				
c	Specific conductance		uS/cm	12600	6780				
c	DOC	0.5	mg/L	4.46	6.92		0.582	1.048	
c	TOC	5	mg/L	5.02	13.8		0.602	1.940	
c	Oil and grease	1	mg/L	1.43	1.89	0.960	0.187	0.348	34.6
c	Ammonia plus Ammonium	0.25	mg/L	2.47	0.999		0.264	0.145	
c	Nitrate+Nitrite	0.25	mg/L	1.18	0.907		0.153	0.152	
c	Total Kjeldahl nitrogen	0.5	mg/L	3.87	1.64		0.458	0.264	
c	Total phosphorus	0.1	mg/L	0.079	0.084	0.069	0.01	0.014	2.49
09	Aluminum	30	ug/L	3710	443	100	0.467	0.068	3.61
09	Boron	50	ug/L	47.6	50.6	14	0.006	0.008	0.505
09	Cadmium	2	ug/L	4.29	4.1	1	0.001	—	0.036
09	Strontium	20	ug/L	1040	496	88	0.11	0.076	3.18
09	Zinc	10	ug/L	25.6	26.5	4	0.003	0.005	0.144
12	Mercury	0.1	ug/L	0.066	0.15	0.019	—	—	—
14	Phenolics (4AAP)	2	ug/L	21	76	1	0.003	0.015	0.0361
15	Sulphide	20	ug/L	45	30		0.004	0.005	
16	Chloroform	0.7	ug/L	54.6	90.7	27	0.007	0.018	0.974
16	Dibromochloromethane	1.1	ug/L	1.19	2.04	4.2	—	0.001	0.151
16	Methylene chloride	1.3	ug/L	1.71	0.86	0.3	—	—	0.011
17	o-Xylene	0.5	ug/L	0.429	0.53	0.4	—	—	0.014
19	Bis(2-ethylhexyl) phthalate	2.2	ug/L	1.4	2.75		—	0.001	
19	Di-n-butyl phthalate	3.8	ug/L	1.1	2.9		—	0.001	
20	Phenol	2.4	ug/L	1.35	1.8		—	—	
23	Hexachlorobenzene	10	ng/L	20.1	13.2	3	—	—	—
23	Pentachlorobenzene	10	ng/L	3.64	9.16	2.1	—	—	—
24	Octachlorodibenzofuran	30	pg/L	26.5	22		—	—	
98	Volume Discharged—Total		m3	127	163				
11	Chloride	2	mg/L	6900	1950		558	390	
13	Sulphate	5	mg/L	4.5	22.5		0.554	4.59	

## Notes

OT0300 is the "Effluent from the Chlorine Filling Unit"; OT 0400 and 0500 are the "Effluents from the Aluminum Chloride Building, respectively the East and South Walls".

BA0100 and BA0200 are the "Effluents from the South and #1 Lagoons" respectively.  
Batch discharges were infrequent and figures are averaged over days when discharge was made.

All discharges follow local run-off/surface drainage conduits to the St. Clair River.

Loadings for intake are calculated from analytical figures and from the sum of the OT flows.





